BNFL Inc.

BNFL-5193-ISAR-01, Rev. 0

TANK WASTE REMEDIATION SYSTEM PRIVATIZATION PROJECT

INITIAL SAFETY ANALYSIS REPORT

January 12, 1998

Prepared for:

U.S. Department of Energy
Richland Operations Office
Contract DE-AC06-RL13308

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ACRONYMS AND ABBREVIATIONS{tc \l1 "ACRONYMS AND ABBREVIATIONS}

AIChE	American Institute of Chemical Engineers
AIHA	American Industrial Hygiene Association
ALARA	as low as reasonably achievable
ALARP	as low as reasonable and practical
BNI	Bechtel National, Inc.
ARF	airborne release fraction
ARI	Air-Conditioning & Refrigeration Institute
ASCE	American Society of Civil Engineers
CAM	continuous air monitor
CBT	computer-based training
CCR	central control room
CEDE	committed effective dose equivalent
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
Ci	curie
CII	Construction Industry Institute
ConOps	Conduct of Operations
CRBG	Columbia River Basalt Group
CSP	Chemical Safety Program
CST	crystalline silico-titanate
DBE	design basis earthquake
DC	Design Class (followed by a Roman numeral)
DCA	design change application
DCN	Design Change Notice
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOE	U.S. Department of Energy
DOELAP	DOE Laboratory Accreditation Program
DOH	Washington State Department of Health
DST	double-shell tank
DWPF	Defense Waste Processing Facility
EAL	Emergency Action Level
EARP	Enhanced Actinide Removal Plant
Ecology	Washington State Department of Ecology
ECP	Employee Concerns Program
EIS	Environmental Impact Statement
EMP	Emergency Management Program
EMS	Emergency Management System
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
EPCRA	*Emergency Planning and Community Right-to-Know Act*
EPG	Environmental Protection Group
EPIP	Emergency Plan Implementing Procedure
EPZ	Emergency Planning Zone
ER	Environmental Report
ERO	Emergency Response Organization
ERPG	emergency response planning guide

ERPP	Environmental Radiation Protection Program
ES&H	environment, safety, and health
ETF	Effluent Treatment Facility
FHA	Fire Hazard Analysis
FR	*Federal Register*
FSAR	Final Safety Analysis Report
FSMP	Fire Safety Management Program
HAL	highly active liquids
HAR	Hazards Analysis Report
HAZOP	hazard and operability (analysis)
HEME	high-efficiency mist eliminator
HEMF	high-efficiency metal filter
HEPA	high-efficiency particulate air (filter)
HFD	Hanford Fire Department
HLW	high-level waste
HMS	Hanford Meterological Station
HQ	Headquarters (U.S. Department of Energy)
HRC	Hazards Research Corporation
HSRCM-1	*Hanford Site Radiological Control Manual*
HVAC	heating, ventilation, and air-conditioning
Hwy	highway
ICBO	International Conference of Building Officials
ICP	Incident Command Post
ICS	Integrated Control System
IHLW	immobilized high-level waste
ILAW	immobilized low-activity waste
ISA	integrated safety analysis
ISAR	Initial Safety Analysis Report
ISC	Integrated Control System
ISMP	Integrated Safety Management Plan
ISO	International Organization of Standards
JIC	Joint Information Center
LAW	low-activity waste
LCR	licensee controlled requirements
LWA	limited work authorization
MAR	material at risk
MIS	Management Information System
MMS	maintenance management system
MSDS	material safety data sheets
MSHA	Mine Safety and Health Administration
MSL	mean sea level
NCRP	National Council on Radiation Protection and Measurements
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NPH	natural phenomena hazards
NRC	U.S. Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
OCRWM	Office of Civilian Radioactive Waste Management

OJT	on-the-job training
OPM	operational preventive measures
ORPS	Occurrence Reporting and Processing System
ORR	operational readiness review
OSHA	Occupational Safety and Health Administration
PAAA	Price-Anderson Amendments Act
PFD	process flow diagram
PHA	process hazards analysis
PHMC	Project Hanford Management Contractor
PMP	probable maximum precipitation
PQAM	Project Quality Assurance Manager
PSAR	preliminary safety analysis report
PSC	(TWRS-P) Project Safety Committee
PSM	Process Safety Management
PUREX	plutonium-uranium extraction
QA	quality assurance
QAIP	quality assurance program implementing plan
QAP	quality assurance program
QAPP	quality assurance program plan
QARD	Quality Assurance Requirements and Description
QL	quality level
QR	quality requirements
RAMI	reliability, availability, maintainability, and inspectability
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction oxidation
rem	roentgen-equivalent man
RF	release fraction
RFD	reverse flow diverter
RG	Regulatory Guide
RIDS	Records Inventory and Disposition Schedule
RL	U.S. Department of Energy, Richland Operations Office
RMP	Risk Management Plan
RPG	Radiological Protection Group
RPP	radiation protection program
RPT	Radiation Protection Technician
RU	regulatory unit
RWP	radiation work permit
SAR	safety analysis report
SCR	selective catalytic reduction
SIC	Standard Industrial Code
SIXEP	Site Ion Exchange Effluent Plant
SNM	special nuclear material
SPD	system performance demonstrations
SPDDD	System Performance Demonstration Definition Documents
SRD	Safety Requirements Document
SSCS	structures, systems, and components
SST	single-shell tank
STD	standard (also Std)

TEDE	total effective dose equivalent
THORP	Thermal Oxide Reprocessing Plant
TRU	transuranic
TSR	technical safety requirement
TWRS	Tank Waste Remediation System
TWRS-P	Tank Waste Remediation System-Privatization
UBC	Uniform Building Code
UK	United Kingdom
UL	Underwriters Laboratory
USC	United States Code
USQ	unreviewed safety question
VPP	Voluntary Protection Program
VSL	Vitreous State Laboratory
WAC	*Washington Administrative Code*
WESF	Waste Encapsulation and Storage Facility
WI	what if
WI/CL	what if/check list
WISHA	Washington Industrial Safety and Health Administration
WVP	Waste Vitrification Plant
YFB	Yakima Fold Belt

1.0 GENERAL INFORMATION{tc \l1 "1.0 GENERAL INFORMATION}

Under the Tank Waste Remediation System-Privatization (TWRS-P) concept, the U.S. Department of Energy (DOE) is purchasing waste processing and immobilization services from contractor-owned and contractor-operated facilities on a fixed-price basis for the treatment of tank wastes stored at the Hanford Site. Waste in the tanks are classified as low activity waste (LAW) and high-level waste (HLW). A description of the generation and past management of the LAW and HLW is provided in Section 1.1.2.1, AHanford Processing Operations.@

The DOE TWRS-P Project is divided into two phases. Phase I is a licensing, permitting, and commercial demonstration effort. During Phase I, 6 to 13% of the tank waste will be processed in a 5- to 9- year period. Phase II will treat the remaining tank waste on a schedule that will remove waste from all single-shell tanks (SSTs) by the year 2018 (DOE-RL 1997a).

Phase I is subdivided into Parts A and B. Part A consists of demonstrating waste treatment technologies, preparing conceptual design, developing safety and regulatory licensing documents (which include this Initial Safety Analysis Report [ISAR]), and establishing a financial plan for the waste treatment facilities. BNFL Inc. is a contractor for Phase I, Part A (DOE-RL 1996d).

Phase I, Part B will consist of constructing and operating one or two separation and immobilization facilities (a maximum of one for LAW only and one for LAW and HLW) to prove the concept of immobilization before treating the remaining waste in Phase II. The LAW-only facility would first separate HLW components (e.g., strontium, transuranics [TRU, elements with an atomic number greater than that of uranium], cesium, and technetium) from the waste streams for onsite dry disposal and return to DOE for vitrification in the HLW facility. The LAW stream would then be vitrified into borosilicate glass, poured into containers, and stored on the Hanford Site. The HLW side of the HLW/LAW facility does not use any prior separation. After dewatering, the entire HLW stream is vitrified, poured into canisters to solidify, and then stored at the Hanford Site until a geologic repository is ready to receive the material.

The LAW waste stream is received from the double-shell tank (DST) 241-AP-106, which is to be operated by BNFL Inc. The HLW waste stream is received from lines running from a new valve pit to be constructed by DOE in the AP tank farm.

This ISAR provides the initial safety assessment for the proposed BNFL Phase I TWRS-P Facility. The ISAR provides the information required by Section 4.2.2, AContractor Input,@ of DOE/RL-96-0003, *DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors* (DOE-RL 1996a). Specifically, the ISAR provides that information required to address Items 1, 2, 5 through 10, and 12 and part of Item 4 of DOE/RL-96-0003, Section 4.2.2. Table 1-1 maps the requirements of Section 4.2.2 to the ISAR and documentation previously submitted by BNFL Inc. to the DOE regulatory unit. The ISAR also provides information required by Table S4-1 of the DOE/BNFL contract (DOE-RL 1996d). Table 1-2 maps the Part A requirements of Table S4-1 to the ISAR and other BNFL deliverables.

Table 1-1. Location of Initial Safety Assessment Package Deliverables

Item[(a)]	Subject [(a)]	Location within the Submittal Packages
1	Description of the design developed during Part A and the proposed facility operations.	Initial Safety Analysis Report (ISAR) Sections 4.2, AFacility Description,@, and 4.3, AProcess Description.@
2	Description of the Contractor=s site and its location within the Hanford Site.	ISAR Section 4.1, ASite Description.@
3	An assessment of compliance to the approved Safety Requirements Document (SRD) and the Integrated Safety Management Plan (ISMP).	ISAR transmittal letter, Attachment A.
4	Description of hazards, including process hazards, and hazards controls implemented in the design and operations.	The description of the hazards is included in the Hazards Analysis Report (HAR) submitted with the Standards Approval Package (BNFL 1997d). A description of the consequence analyses that followed the hazards identification process is included in ISAR Section 4.7, AResults of the Integrated Safety Analysis.@ A description of the hazards controls is provided in ISAR Section 4.8, AControls for Prevention and Mitigation of Accidents,@ and HAR Section 6.2, AControls.@
5	Description of the potential design-basis events.	ISAR Section 4.7.
6	Analysis of the potential design-basis events.	ISAR Section 4.7.
7	Preliminary safety acceptance criteria against which the consequences of the potential design-basis events are compared for acceptability.	ISAR Section 4.7.
8	Description of structures, systems, and components (SSCs) designated as important to safety and the rationale for their selection.	For the TWRS-P Project, SSCs credited for public and worker safety for maintaining exposures below accident standards are designated as Design Class I and Design Class II, respectively. The definition of these terms and the rational for classifying SSCs as such are provided in ISAR Section 4.6, AIntegrated Safety Assessment Methods.@ A description of SSCs so classified is provided in Section 4.7 of the ISAR.
9	The Contractor=s evaluations of constructability, operability, reliability, availability, maintainability, and inspectability.	The evaluation of the constructability of the TWRS-P Facility and the inspectability of its structural aspects are provided in Section 4.2 of the ISAR. The evaluation of the operability, reliability, availability, and maintainability of the process systems is provided in Section 4.3. This section also addresses the inspectability of the process systems.

Table 1-1. Location of Initial Safety Assessment Package Deliverables

Item[a]	**Subject** [a]	**Location within the Submittal Packages**
10	An ISAR that:	
a)	Defines the projected safety basis for the facility (safety envelope) in terms of physical design, structures with prescribed safety functions, systems with prescribed safety functions, equipment with prescribed safety functions, operating modes, operating conditions, representative off-normal internal events, representative external events, representative safety analyses and results, and major uncertainties in data and analyses.	Physical design - ISAR Sections 4.2 and 4.3. Structures w/safety functions - ISAR Section 4.2. Systems w/safety functions - ISAR Section 4.3. Equipment w/safety functions - ISAR Section 4.3. Operating modes and conditions - ISAR Section 4.3. Off-normal internal events - ISAR Section 4.7. External events - HAR Section 2.1, ASite Description.@ Representative safety analysis results - ISAR Section 47. Major uncertainties in data and analysis - ISAR Section 4.7.
b)	Describes how the facility should perform such that the radiological, nuclear, and process safety standards and requirements in the SRD and in applicable regulations are met.	ISAR Section 4.7. Applicable regulations as they relate to radiological, nuclear, and process safety are incorporated into the SRD (BNFL 1997g).
c)	Describes how adequate protection of the public, the workers, and the environment should be achieved.	ISAR Section 4.7.
11	Draft deactivation plan.	The deactivation plan is provided separately as the *TWRS-P Privatization Project: Deactivation Plan,* (BNFL 1998b). This is deliverable A-9 of Table 4-1 of the contract (DOE-RL 1996d).
12	Outlines of:	
a)	Construction Authorization Request.	By Table S4-1 of the contract, this outline is a Part B deliverable.
b)	Operating Authorization Request.	By Table S4-1 of the contract, this outline is a Part B deliverable.
c)	Emergency Response Plan.	ISAR Chapter 9.0, A Emergency Management.@
d)	Unreviewed Safety Question Plan.	ISAR Section 3.1, AConfiguration Management.@
e)	Conduct of Operations Plan.	ISAR Section 3.11, AOperational Practices.@
f)	Technical Safety Requirements.	ISAR Section 4.8, AControls for Prevention and Mitigation of Accidents.@
g)	Training and Qualification Plan.	ISAR Section 3.4, ATraining and Qualification.@
h)	Maintenance Implementation Plan.	ISAR Section 3.2, AMaintenance.@
i)	Occurrence Reporting Procedures.	ISAR Section 3.7, AIncident Investigations.@
j)	Environmental Radiological Protection Program.	ISAR Chapter, 5.0, ARadiation Safety,@ Appendix 5B, AEnvironmental Radiological Protection Program-Outline.@
k)	Radiation Protection Program.	ISAR Chapter, 5.0, Appendix 5A, ARadiation Protection Program-Outline.@

Table 1-1. Location of Initial Safety Assessment Package Deliverables

Item[a]	Subject [a]	Location within the Submittal Packages
l)	Operational Analysis and Assessment Reports.	ISAR Section 3.6, ΑAudits and Assessments.@
m)	Deactivation Safety Assessment.	By Table S4-1 of the contract, this outline is a Part B deliverable.
n)	Deactivation Authorization Request.	By Table S4-1 of the contract, this outline is a Part B deliverable.

[a] The item numbers and subject descriptions are as provided in Section 4.2.2 of *DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors*, DOE/RL-96-0003, (DOE-RL 1996a) Revision 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Table 1-2. Submittal of Contract Table S4-1 Deliverables

Regulatory Action	Deliverable	Submittal
Standards Approval	Safety Requirements Document.	*TWRS-P Privatization Project: Safety Requirements Document,* BNFL-5193-SRD-01 (BNFL 1997g).
	Integrated Safety Management Plan.	*TWRS-P Privatization Project: Integrated Safety Management Plan,* BNFL-5193-ISP-01 (BNFL 1997e).
	Hazard Analysis Report.	*TWRS-P Privatization Project: Hazard Analysis Report,* BNFL-5193-HAR-01 (BNFL 1997d).
	Employee Concerns Management System.	*TWRS-P Privatization Project: Employee Concerns Program,* BNFL-5193-ECP-01 (BNFL 1997b).
	Radiation Exposure Standard for Workers Under Accident Conditions.	*TWRS Privatization Project: Radiological and Nuclear Dose Standards for Facility and Co-Located Workers,* BNFL-5193-RES-01 (BNFL 1997f).
	Quality Assurance Program.	*Tank Waste Remediation System Privatization Project Quality Assurance Program* BNFL-5193-QAP-01 (BNFL 1997a).
Initial Safety Evaluation	Initial Safety Assessment.	See Table 1-1.
Authorization for Construction	Deactivation Plan, outline.	*TWRS-P Privatization Project: Deactivation Plan,* BNFL-5193-DP-01 (BNFL 1998b). This is deliverable A-9 of Table 4-1 of the contract (DOE-RL 1996d).
Authorization for Deactivation	Part B deliverable	Not applicable

Table 1-2. Submittal of Contract Table S4-1 Deliverables

Regulatory Action	Deliverable	Submittal
Standards Approval	Safety Requirements Document.	*TWRS-P Privatization Project: Safety Requirements Document,* BNFL-5193-SRD-01 (BNFL 1997g).
	Integrated Safety Management Plan.	*TWRS-P Privatization Project: Integrated Safety Management Plan,* BNFL-5193-ISP-01 (BNFL 1997e).
	Hazard Analysis Report.	*TWRS-P Privatization Project: Hazard Analysis Report,* BNFL-5193-HAR-01 (BNFL 1997d).
	Employee Concerns Management System.	*TWRS-P Privatization Project: Employee Concerns Program,* BNFL-5193-ECP-01 (BNFL 1997b).
	Radiation Exposure Standard for Workers Under Accident Conditions.	*TWRS Privatization Project: Radiological and Nuclear Dose Standards for Facility and Co-Located Workers,* BNFL-5193-RES-01 (BNFL 1997f).
	Quality Assurance Program.	*Tank Waste Remediation System Privatization Project Quality Assurance Program* BNFL-5193-QAP-01 (BNFL 1997a).
Initial Safety Evaluation	Initial Safety Assessment.	See Table 1-1.
Authorization for Construction	Deactivation Plan, outline.	*TWRS-P Privatization Project: Deactivation Plan,* BNFL-5193-DP-01 (BNFL 1998b). This is deliverable A-9 of Table 4-1 of the contract (DOE-RL 1996d).
Authorization for Production Operation	Safety Analysis Report, initial.	This Initial Safety Evaluation Report (ISAR).
	Emergency Response Plan, outline.	ISAR Chapter 9.0.
	Unreviewed Safety Question Plan, outline.	ISAR Section 3.1.
	Conduct of Operations Plan, outline.	ISAR Section 3.11.
	Technical Safety Requirements, outline.	ISAR Section 4.8.
	Training and Qualification Plan, outline.	ISAR Section 3.4.
	Maintenance Implementation Plan, outline.	ISAR Section 3.2.
	Occurrence Reporting Procedures, outline.	ISAR Section 3.7.

Table 1-2. Submittal of Contract Table S4-1 Deliverables

Regulatory Action	Deliverable	Submittal
Standards Approval	Safety Requirements Document.	*TWRS-P Privatization Project: Safety Requirements Document,* BNFL-5193-SRD-01 (BNFL 1997g).
	Integrated Safety Management Plan.	*TWRS-P Privatization Project: Integrated Safety Management Plan,* BNFL-5193-ISP-01 (BNFL 1997e).
	Hazard Analysis Report.	*TWRS-P Privatization Project: Hazard Analysis Report,* BNFL-5193-HAR-01 (BNFL 1997d).
	Employee Concerns Management System.	*TWRS-P Privatization Project: Employee Concerns Program,* BNFL-5193-ECP-01 (BNFL 1997b).
	Radiation Exposure Standard for Workers Under Accident Conditions.	*TWRS Privatization Project: Radiological and Nuclear Dose Standards for Facility and Co-Located Workers,* BNFL-5193-RES-01 (BNFL 1997f).
	Quality Assurance Program.	*Tank Waste Remediation System Privatization Project Quality Assurance Program* BNFL-5193-QAP-01 (BNFL 1997a).
Initial Safety Evaluation	Initial Safety Assessment.	See Table 1-1.
Authorization for Construction	Deactivation Plan, outline.	*TWRS-P Privatization Project: Deactivation Plan,* BNFL-5193-DP-01 (BNFL 1998b). This is deliverable A-9 of Table 4-1 of the contract (DOE-RL 1996d).
	Environmental Radiation Protection Program, outline.	ISAR Appendix 5B.
	Radiation Protection Program, outline.	ISAR Appendix 5A.
Oversight Process Determination	Operational Assessment Reports, outline.	ISAR Section 3.6.

The ISAR uses the format and content guidance provided in the U.S. Nuclear Regulatory Commission=s (NRC=S) Regulatory Guide 3.52, *Standard Format and Content for the Health and Safety Sections of License Applications for Fuel Cycle Facilities* (NRC 1995a draft). To facilitate the review of the ISAR by the DOE regulatory unit, the ISAR content also gives consideration to the review guidance provided in *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*, NUREG-1520 (NRC 1995b draft), and *Guidance for the Review of TWRS Privatization Contractor Initial Safety Assessment Package* (DOE-RL 1997).

The format and content of the ISAR is tailored to the hazards and hazardous situations of the TWRS-P Facility as identified by the process hazards analysis and as documented in the Hazards Analysis Report (HAR) (BNFL 1997d). Section 4.2.3, ATailoring of Safety-Related Documentation,@ of the Integrated Safety Management Plan (ISMP) provides a list of deviations from the format and content guidance of Regulatory Guide 3.52. These deviations include both format changes in terms of added ISAR sections and content changes for several of the ISAR sections.

Throughout the ISAR, lists of items are numbered for the convenience of the reviewers in referring to individual items. The numbering is not an indication of the importance or sequence of the items unless indicated otherwise.

Chapter 12.0, ADefinitions,@ contains the definitions of the terms, phrases, or documents that are found throughout the ISAR.

When used unmodified in the ISAR, the term Aworker@ refers to the facility and co-located worker, both individually and collectively.

1.1 FACILITY AND PROCESS DESCRIPTIONS{tc \l2 "1.1 FACILITY AND PROCESS DESCRIPTIONS}

This section provides a summary of the TWRS-P Facility in terms of the major structures and chemical process systems. Details on these aspects of the TWRS-P Facility are provided in Sections 4.2, AFacility Description,@ and 4.3, AProcess Description.@

1.1.1 Facility Description{tc \l3 "1.1.1 Facility Description}

The TWRS-P Facility for treating both the LAW-only option and the HLW/LAW option includes the following major structures:

1) Process building
2) Wet chemical store
3) Glass formers store
4) Melter assembly building
5) Empty canister store
6) Services buildings
7) Administration building.

Structures associated with the operation of tank 241-AP-106 include the following:

1) Tank 241-AP-106 service building
2) Central pump pit/transfer pump pit enclosure building
3) Transfer pump pit.

Transfer lines are also provided to receive the LAW from tank 241-AP-106 and HLW waste from a new valve pit to be constructed by DOE in the AP tank farm.

Buildings that are important to the Integrated Safety Analysis (ISA) because they house the primary process cells or provide for transfer or storage of hazardous and radiological materials are the process building, wet chemical store, glass formers store, tank 241-AP-106 service building, central pump pit/transfer pump pit enclosure building, and the transfer pump pit. Details on these buildings, including drawings, are provided in Section 4.2, AFacility Descriptions.@ The arrangements of the major buildings are shown in Figure 1-1. The function and contents of those buildings identified as being important to the ISA are described in the following sections.

1.1.1.1 Process Building{tc \l4 "1.1.1.1 Process Building}. The process building for the LAW-only option contains processes for conditioning (i.e., pretreatment) and immobilization of the LAW feeds. For the HLW/LAW option, the processes for conditioning and immobilizing HLW are also included. Additionally, for the LAW-only option, the process building includes an area for producing an intermediate waste form from the cesium separated from the LAW feeds. A shipping container handling area containing a drive-through bay is provided at the northeast corner of the building. Shipping containers provided by DOE are removed from a transport vehicle. Immobilized LAW, cesium intermediate waste packages (LAW-only option), and HLW containers are loaded into the shipping containers, and the shipping containers are placed onto the transport vehicle.

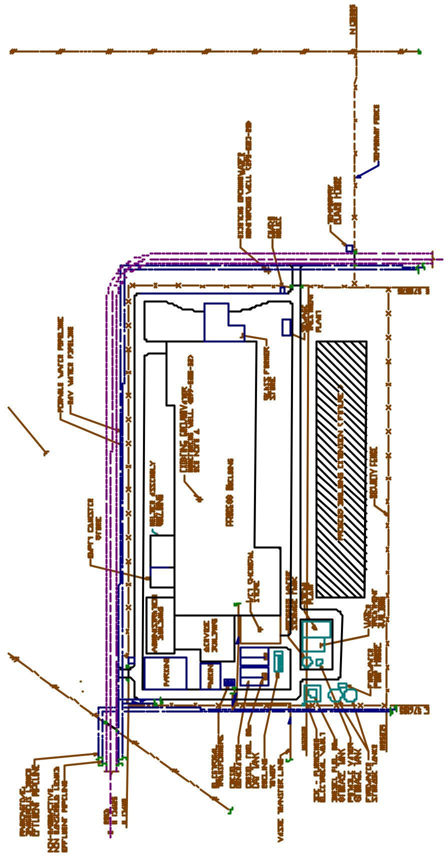
In the HAR submittal, the process building was referenced as the radioactive waste treatment building. The immobilized waste treatment building mentioned in the HAR is also incorporated into the process building.

1.1.1.2 Wet Chemical Store{tc \l4 "1.1.1.2 Wet Chemical Store}. The wet chemical store is located at grade on the southwest side of the process building. The building is subdivided into an ion-exchange resin storage area and a bulk chemical reagents storage area. The ion-exchange resins storage area is enclosed by walls and has environment controls to prevent damage to the stored materials. The bulk chemical reagents storage area is not enclosed by walls; it is covered with a roof to protect the chemicals from the weather. The bulk chemicals are stored in tanks within spill retention basins. Dry chemicals (e.g., ferric nitrate, strontium nitrate, and sodium nitrite) are stored separately in this area as well.

1.1.1.4 Glass Formers Store{tc \l4 "1.1.1.4 Glass Formers Store}. The glass formers store provides for receipt, storage, weighing, and blending of the bulk glass-making chemicals. The building is located at the east end of the process building. The building provides space for one transport bin and eleven storage silos and the weighing, blending, and transfer equipment.

1.1.1.5 Tank 241-AP-106 Service Building. The tank 241-AP-106 service building supports new ventilation, instrumentation, electrical, and flushing equipment for tank 241-AP-106.

1.1.1.6 Central Pump Pit/Transfer Pump Pit Enclosure Building. The new pump pit enclosure provides both secondary confinement and weather protection to the mixer and transfer pump drive motors, the actuated transfer control valves, and pit instrumentation.



1.1.1.7 Transfer Pump Pit{tc \l4 "1.1.1.7 Transfer Pump Pit}. A new cast in place or modular precast concrete transfer pump pit is installed above tank 241-AP-106 risers 5 and 13 to provide locations for two new transfer pumps and transfer control valves.

1.1.2 Process Description{tc \l3 "1.1.2 Process Description}

This section discusses Hanford Site past-processing operations and the TWRS-P processing operations as they relate to the ISA. The past processing of the waste led to the addition of more chemicals to the HLW than normally associated with fuel reprocessing. This processing reduced the radionuclide concentration of waste while increasing the chemical complexity. For the TWRS-P Facility to successfully process this waste, it must separate the radionuclides from the diluted waste while taking into account the additional chemicals (e.g., chelating agents).

1.1.2.1 Hanford Site Processing Operations{tc \l4 "1.1.2.1 Hanford Site Processing Operations}. The principal mission of the Hanford Site from 1943 to 1989 was the production of plutonium for the national defense activities. To produce plutonium, uranium metal was irradiated in one of nine plutonium production reactors. The discharged fuel (spent fuel) was cooled and then treated in separations facilities to recover the plutonium. To separate the plutonium from uranium and other radioactive materials, the spent fuel was dissolved in nitric acid. The separation processes produced large quantities of nitric acid solutions containing high levels of radioactive materials. The waste included high-level and transuranic mixed radioactive waste (radioactive and hazardous).

The chemicals in the Hanford Site tank system resulted from four separation processes and two waste management campaigns. The changes in separation processes were a result of improvements in separations technology. Although the waste in the tank system came primarily from these four sources, some of the waste resulted (to a much smaller extent) from decontamination solutions, laboratory waste, research and development programs, and plutonium-finishing activities.

The process campaigns consisted of the bismuth phosphate process in B Plant and T Plant, reduction oxidation (REDOX) process in S Plant plutonium-uranium reduction oxidation process (PUREX) in A Plant, and uranium recovery process in U Plant. Prior to discharge of the nitric acid waste to the underground tanks, the waste was neutralized with sodium carbonate and sodium hydroxide. Between 1944 and 1964, 149 SSTs were built to store the HLW. Between 1968 and 1986, 28 DSTs were built to store HLW.

The bismuth phosphate process separated uranium from plutonium by carrier precipitation. Plutonium was further purified by a second precipitation process using rare earths. Both the uranium-rich and purification solids were discharged to tank farms. The uranium waste fed to a cascade of three tanks with the discharge from the last tank going to the soil column.

The REDOX process extracted both plutonium and uranium from the dissolved fuel using hexone as the solvent. This process led to an increase in radionuclide concentrations and the increased waste temperature caused the waste to boil. This self-boiling further reduced the waste volume.

The uranium recovery process extracted uranium from the bismuth phosphate solids using the tri-Butyl phosphate process. The solids were sluiced from the tanks, re-acidified, processed in U Plant, neutralized again, and then returned to tank farms.
The PUREX process processed the vast majority of fuel. The primary waste from this process was transferred to the A Farm complex. Early cladding waste and solvent treatment waste were transferred to the 241-C Tank Farm. Later, cladding waste from the Zirflex process was also discharged to the A Farm complex.

The waste management campaigns included radionuclide precipitation and radionuclide recovery. The main purpose of the precipitation campaign was to make additional space in the tanks. The recovery campaign was intended to reduce heat generation in the tanks and to produce useful by-products.

As an adjunct to the uranium recovery process, chemicals were added to the waste to precipitate cesium and strontium to allow discharge of supernatants to the soil column. Both in-tank and in-plant precipitation were used to accomplish this treatment. The treated supernatants were then discharged to the 241-BY Crib and the 241-BC Crib.

Cesium and strontium recovery programs fractionated the waste from B Plant and returned the waste to tank farms. The recovery of strontium used several chelating agents to improve the efficiency of solvent extraction operations. These agents provided one of the major sources of organic compounds in the tanks. The Waste Encapsulation and Storage Facility (WESF) converted the separate cesium and strontium into stable compounds for storage and placed the material in capsules for storage in water basins.

1.1.2.2 TWRS-P Processing Operations{tc \l4 "1.1.2.2 TWRS-P Processing Operations}. The TWRS-P Facility provides for treating LAW and HLW. The TWRS-P Facility chemical processes can be subdivided into eight distinct unit operations, which are described below. The overall process is a combination of semi-batch and batch unit operations comprised of the following operations:

1) Receipt of LAW Feeds - DOE samples, analyzes, and transfers batches of LAW feed into the DST 241-AP-106 operated by BNFL Inc. The feed batch is mixed to ensure uniform consistency and a portion is transferred through an underground pipeline to the treatment facility.

2) LAW Entrained Solids and Strontium/TRU Separation - The solids in the feed are concentrated to about 50 volume percent using ultrafiltration. The slurry is then washed to reduce the sodium level in the entrained solids slurry to within acceptable limits. The filtrate from this operation is then fed to cesium removal. For Envelope C feed (see Section 1.2.4, AType, Quantity, and Form of Waste Material@), the same equipment is used to sequentially remove the entrained solids followed by the strontium and TRU precipitate, and then to feed these two products to separate storage.

3) LAW Cesium Removal - Cesium is removed from the filtrate using ion-exchange technology and the liquor passes to technetium removal.

4) LAW Technetium Removal - Technetium is also extracted using ion-exchange technology. The liquid is evaporated and passed to the vitrification system.

5) LAW Vitrification - The LAW generated after technetium removal is vitrified in the final unit operation, the LAW melter. The waste is fed to a number of melter systems to produce glass for return to DOE. The separated entrained solids (see item 2 above) are also returned to DOE.

6) Receipt of HLW Feed - Envelope D receipt vessels are required to receive a slurry of waste solids.

7) HLW Dewatering - Pretreatment of the Envelope D feed is required to reduce the water content of the feed to the HLW melter. Ultrafiltration is used for the dewatering operation. The permeate from the ultrafilter circuit is combined with the permeate from the LAW ultrafilter circuit for radionuclide separation processing.

8) HLW Vitrification - The separated cesium, technetium, and strontium/TRU intermediate products are immobilized in the HLW melter together with the concentrated Envelope D material.

Figures 1-2 and 1-3 show the LAW and HLW/LAW processes, respectively.

Additional details on the processes for treatment and immobilization of the LAW and HLW are described in ISAR Section 4.3, AProcess Description,@ and Chapter 5.0, AHazard Evaluation by Process Step,@ of the Hazards Analysis Report (BNFL 1997d).

1.2 INSTITUTIONAL INFORMATION{tc \l2 "1.2 INSTITUTIONAL INFORMATION}

Section 1.2 provides information on the incorporation of BNFL Inc., the locations of BNFL Inc. offices important to the TWRS-P Project, the location of the proposed TWRS-P Facility and its site, and the activity to be performed by the facility.

1.2.1 Identity and Address{tc \l3 "1.2.1 Identity and Address}

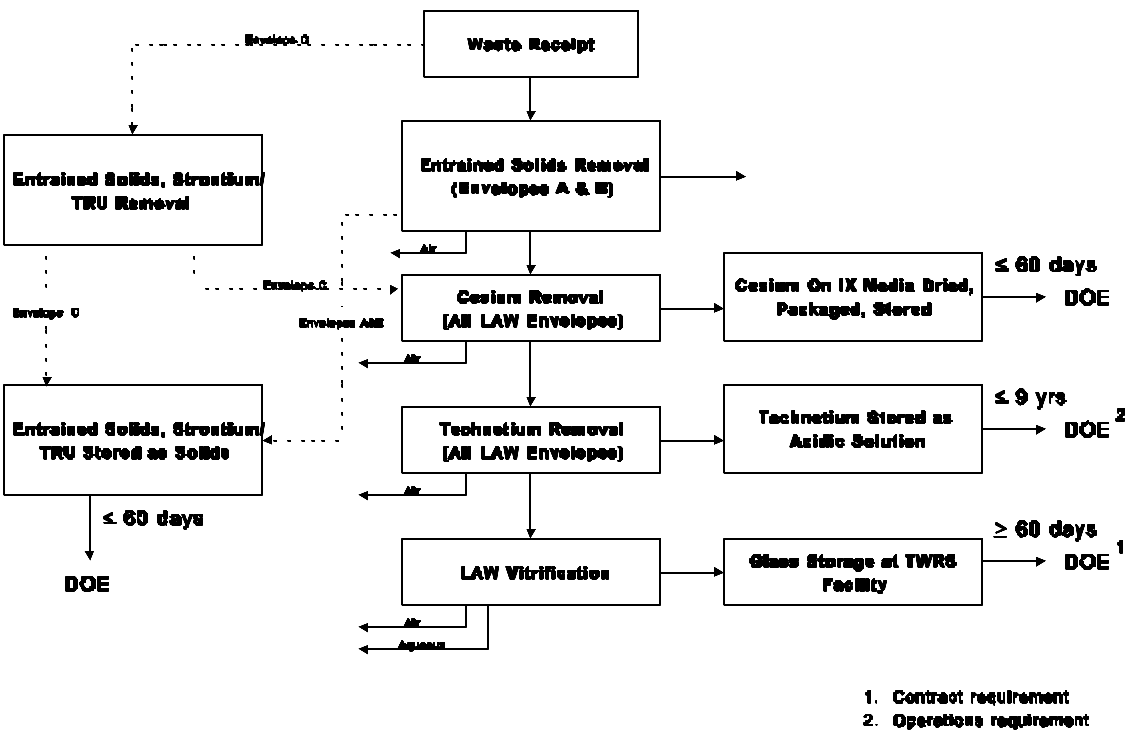
This ISAR is submitted by BNFL Inc., a wholly owned U.S. subsidiary of British Nuclear Fuels plc (BNFL). The principal office of BNFL Inc. is located at 10306 Eaton Place, Suite 450, Fairfax, Virginia, 22030. BNFL Inc. is incorporated in the State of Delaware. The local address for BNFL Inc. is 1835 Terminal Drive, Suite 220, Richland, Washington, 99352.

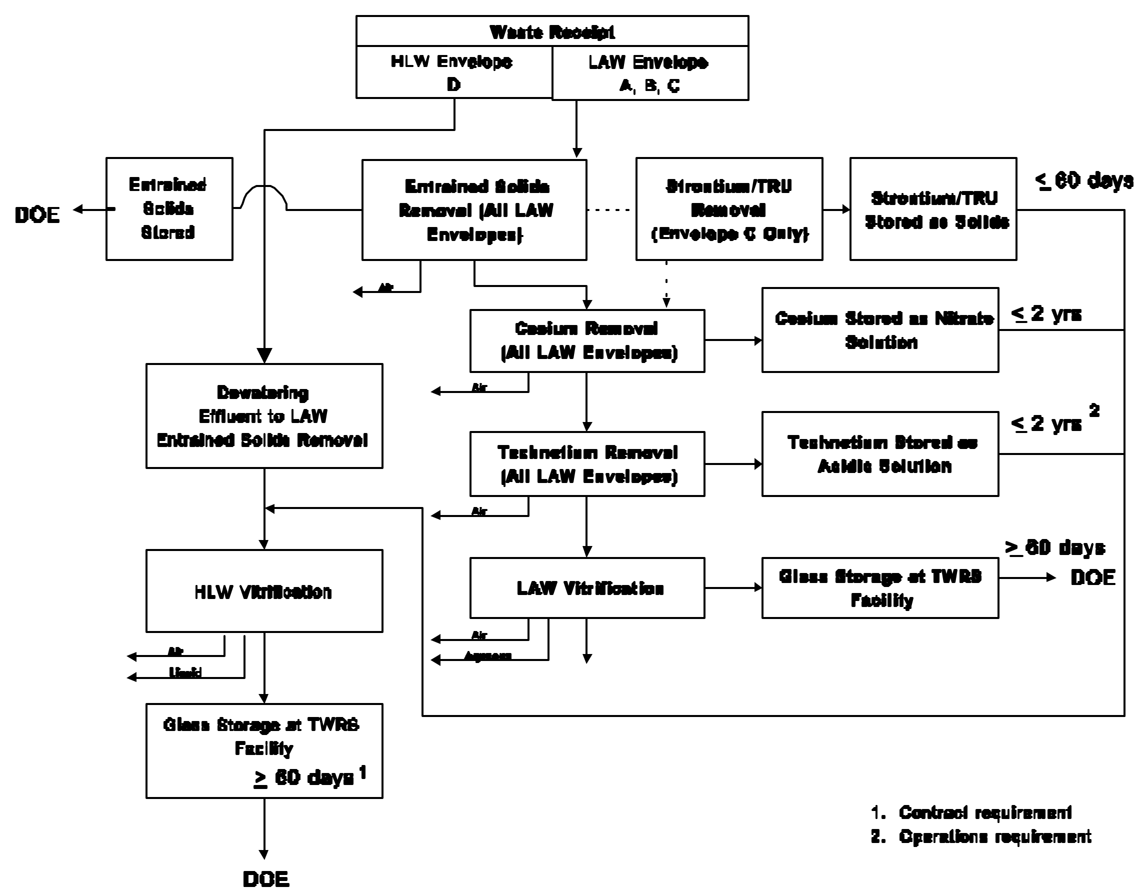
1.2.2 Activities Performed{tc \l3 "1.2.2 Activities Performed}

The activities performed at the TWRS-P Facility are the processing and immobilization of Hanford Site tank waste. The chemical processes by which this is accomplished are addressed above in Section 1.1.2 AProcess Description.@

1.2.3 Site Location{tc \l3 "1.2.3 Site Location}

The Hanford Site occupies an area of about 1,450 km^2 (560 mi^2) and is located north of the city of Richland, at the confluence of the Yakima River and the Columbia River. The TWRS-P Facility is to be constructed at the east end of the 200 East Area of the Hanford Site. The Hanford Site is surrounded by Benton, Franklin, and Grant counties. Additional information of the site is provided in Sections 1.3 and 4.1, both titled ASite Description.@


Waste Receipt
Envelope C
Entrained Solids, Strontium/ TRU Removal
Entrained Solids Removal (Envelopes A & B)
Air
Envelope C
Envelope C
Envelopes A&B
Cesium Removal [All LAW Envelopes]
Cesium On IX Media Dried, Packaged, Stored
≤ 60 days
DOE
Air
Entrained Solids, Strontium/ TRU Stored as Solids
≤ 60 days
DOE
Technetium Removal [All LAW Envelopes]
Technetium Stored as Acidic Solution
≤ 9 yrs
DOE 2
Air
LAW Vitrification
Glass Storage at TWRS Facility
≥ 60 days
DOE 1
Air
Aqueous
1. Contract requirement
2. Operations requirement


Waste Receipt
HLW Envelope D
LAW Envelope A, B, C
DOE
Entrained Solids Stored
Entrained Solids Removal (All LAW Envelopes)
Strontium/TRU Removal (Envelope C Only)
Strontium/TRU Stored as Solids
≤ 60 days
Air
Cesium Removal (All LAW Envelopes)
Cesium Stored as Nitrate Solution
≤ 2 yrs
Dewatering Effluent to LAW Entrained Solids Removal
Air
Technetium Removal (All LAW Envelopes)
Technetium Stored as Acidic Solution
≤ 2 yrs 2
Air
≥ 60 days
HLW Vitrification
LAW Vitrification
Glass Storage at TWRS Facility
DOE
Air
Liquid
Air
Aqueous
Glass Storage at TWRS Facility
≥ 60 days 1
DOE
1. Contract requirement
2. Operations requirement

1.2.4 Type, Quantity, and Form of Waste Material{tc \l3 "1.2.4 Type, Quantity, and Form of Waste Material}

The primary purpose of the separations facilities at the Hanford Site was the extraction of plutonium from fuel discharged from the production reactors. The waste resulting from the separations activities are stored in underground tanks on the Site. The waste is the principal feed for the TWRS-P Facility. While the bismuth-phosphate facilities (i.e., B plant and T Plant) did discharge uranium to the SSTs, this uranium was later recovered and purified by the Uranium-TriOxide Plant. The REDOX and the PUREX separations facilities produced uranium nitrate for recycle. As a result of these processes, there are minor amounts of special nuclear material in the tank waste to be processed by the TWRS-P Facility.

The DOE has classified these wastes into four separate envelopes: three LAW (Envelopes A, B, and C) and one HLW (Envelope D). In general terms, a description of each of the envelopes is as follows.

1) Envelope A - This envelope makes up the majority (approximately 90%) of the minimum order quantities. This envelope contains cesium and technetium at concentrations that result in the need for their removal to ensure that the LAW glass specification can be met.

2) Envelope B - This envelope contains higher concentrations of cesium than the Envelope A. Both cesium and technetium require removal to ensure that the LAW glass specifications are met. This envelope also contains higher concentrations of chlorine, chromium, fluorine, phosphates, and sulfates, which may limit the waste loading in the glass.

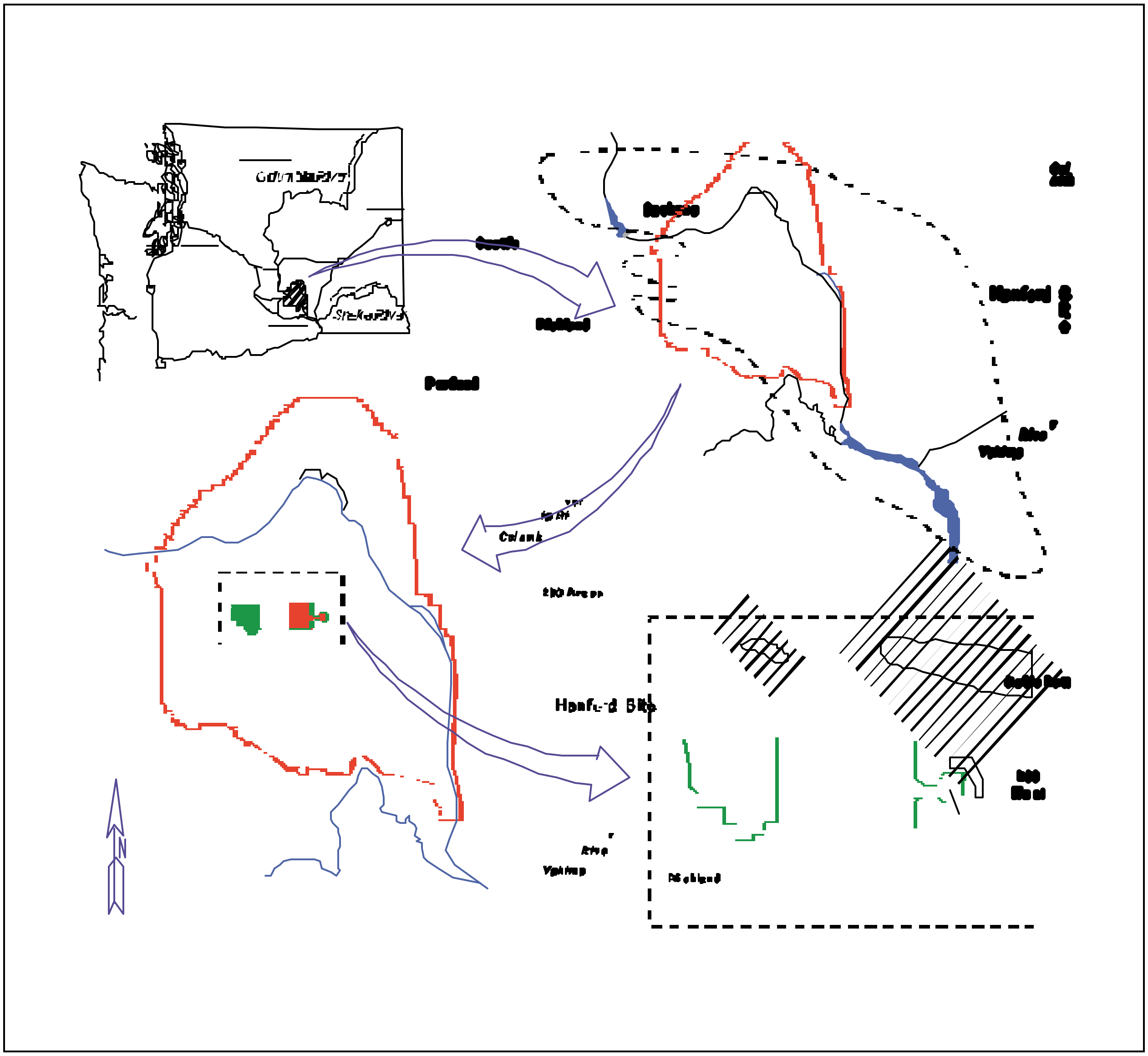
3) Envelope C - This waste envelope contains organically complexed strontium and TRUs that will require removal. Cesium and technetium also require removal to ensure that the LAW glass specifications are met.

4) Envelope D - This waste envelope contains a HLW slurry.

1.3 SITE DESCRIPTION{tc \l2 "1.3 SITE DESCRIPTION}

The Hanford Site is located in the State of Washington (Figure 1-4). The Columbia River enters the Hanford Site boundary at the northwest corner and crosses over to form the eastern boundary of the Site as it flows southward. The Yakima River flows from west to east, south of the Hanford Site, and empties into the Columbia River at the conjoined cities of Kennewick, Pasco, and Richland, known collectively as the Tri-Cities. The Hanford Site is bordered on the north by the Saddle Mountains and on the west by the Rattlesnake Hills and the Yakima and Umtanum Ridges. Dominant natural features of the Hanford Site include the Columbia River, anticlinal ridges of basalt in and around the Site, and sand dunes near the Columbia River. The surrounding basaltic ridges rise to 1,100 m (3,610 ft). Additional information on the Hanford Site and the surrounding area, including the geography, demography, seismology and geology, and meteorology, is provided in Section 4.1, ASite Description.@

In 1943, the Federal government established the Hanford Site near Richland, Washington, to produce plutonium for national defense purposes. The production mission stopped in 1988. The current Site mission is waste management and environmental restoration, which includes programs



to manage and dispose of radioactive, hazardous, and mixed wastes that exist at the Site.

The 200 Areas have been used extensively for fuel reprocessing, waste management, and disposal activities. In addition to the waste tanks and the cesium and strontium capsules, the 200 Areas are the location of several fuel reprocessing facilities that are inactive or scheduled for deactivation, buried solid waste, and irradiated fuel storage.

In the 200 Areas, there are 149 SSTs constructed between 1944 and 1964, and received waste until 1980. Waste in the SSTs consists of liquid, sludges, and saltcake (i.e., crusty solids made of crystallized salts). Over the years, much of the liquid stored in the SSTs has been evaporated or pumped into DSTs. There are 28 DSTs at the Hanford Site that were constructed between 1968 and 1986. The DSTs store liquid radioactive mixed waste from the SSTs and various Hanford Site processes. The waste is partially segregated and stored in tanks based on composition, level of radioactivity, or origin.

In addition to the 177 underground storage tanks, there are approximately 40 inactive and 20 active miscellaneous underground storage tanks located in the 200 Areas. These tanks contain small quantities of mixed waste similar in content and composition to the wastes in the SSTs and DSTs.

In WESF of the 200 East Area, cesium and strontium are stored in approximately 1,930 double-walled capsules. In the 1960s and 1970s, radioactive cesium and strontium were extracted from waste forms in some SSTs to reduce the heat load to the tanks. The cesium and strontium were stabilized to salt forms and placed in stainless-steel capsules.

The DOE is to lease up to 24.3 hectares (60 acres) of the Hanford Site to BNFL Inc. for the construction of the TWRS-P Facility. Of this land, 8.9 hectares (22 acres) will be used for siting the permanent facilities and the remainder will be used for construction facilities. The land to be leased lies at the eastern end of the Hanford Site 200 East Area, near the former Grout Treatment Facility, the A Tank Farm Complex, the PUREX plant, and several underground low-level radioactive waste percolation fields. The location of the Hanford Site within the State of Washington and the location of the BNFL Inc.-leased land within the Hanford Site are shown in Figure 1-4.

2.0 MANAGEMENT ORGANIZATION{tc \l1 "2.0 MANAGEMENT ORGANIZATION}

The Tank Waste Remediation System-Privatization (TWRS-P) Project supports the U.S. Department of Energy=s (DOE=s) mission to clean up the Hanford Site by managing and reducing hazards associated with the radioactive mixed waste stored in large underground storage tanks at the Hanford Site. BNFL=s safety approach for the TWRS-P Project has been proven through years of operating experience and is driven by the requirement to operate the facility in a manner that provides adequate protection for the health and safety of the public, ensures worker health and safety, is protective of the environment, and complies with applicable laws and regulations. The BNFL Inc. safety approach is implemented with the recognition that the defined work for processing and immobilizing Hanford Site tank waste involves inherent radiological and chemical hazards from which hazardous situations may arise.

This chapter provides an overview of the BNFL Inc. organizational structure, responsibilities, interfaces, management controls, and safety committees that support safe design, construction, operations and deactivation activities of Phase I of the TWRS-P Project. *(The organization will be developed further during Part B of the TWRS-P Project to support the detailed design, construction, operation, and deactivation of the facility.)*

2.1 ORGANIZATION AND ADMINISTRATION{tc \l2 "2.1 ORGANIZATION AND ADMINISTRATION}

The BNFL Inc. organization accomplishes the TWRS-P Project-defined work in a manner that provides for the health and safety of workers and the public and protects the environment from degradation. The design, construction, operation, and deactivation of the TWRS-P Facility represent an integrated effort between DOE and BNFL Inc. A summary of the roles and responsibilities of the TWRS-P Facility staff and the interfaces with DOE and the TWRS-P Project regulator are presented below.

The philosophy of the BNFL Inc. organizational structure is determined by the need to ensure that safety is achieved, while at the same time meeting the customer=s requirements in an efficient manner. The organizational structure for the TWRS-P Project presents the BNFL Inc. approach to assigning responsibility for managing work safely. Assigning these roles provides additional assurance that the roles identified in the Safety Analysis Reports are performed. This organization is staffed with suitably qualified and experienced personnel to cover normal operation and off-normal situations. Contractor support organizations meet the same safety criteria in terms of structure, strength, available expertise, and material resources for their scope of work.

2.1.1 Organizational Commitments, Relationships, Responsibilities, and Authorities{tc \l3 "2.1.1 Organizational Commitments, Relationships, Responsibilities, and Authorities}

The TWRS-P Project-defined work is to remove and process radioactive mixed waste from Hanford Site underground storage tanks. To provide support during Part B, the organizational structure transitions from a design and construction organization to an operations and deactivation organization. Part B includes the following tasks:

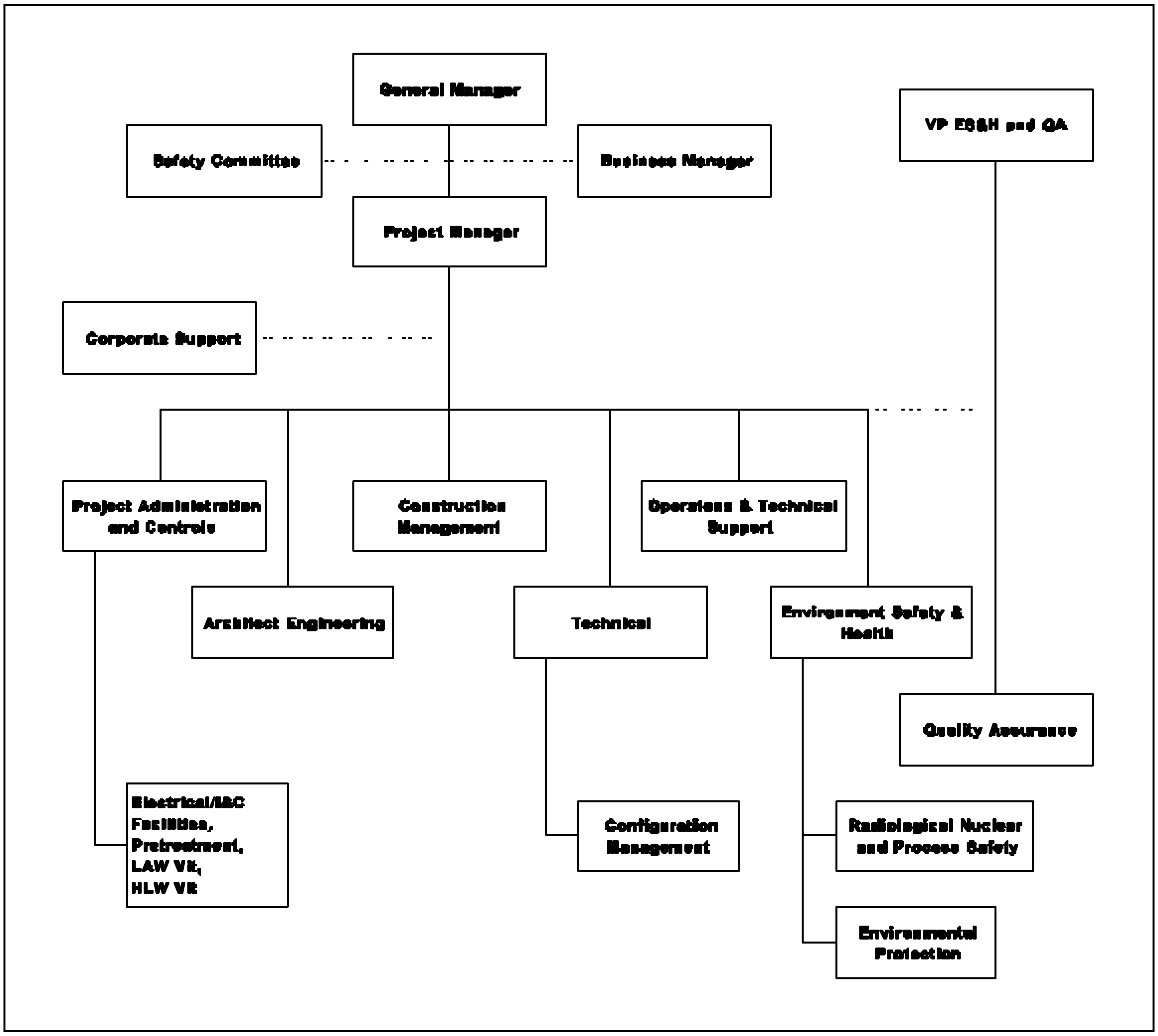
1) Part B1 - the detail design, licensing, permitting, and construction phase

2) Part B2 - the cold test, hot startup, operations, and deactivation phase of the Phase I TWRS-P demonstration project.

BNFL Inc. is responsible for the design, construction, operation, and deactivation of the TWRS-P Facility. This responsibility includes developing and implementing safety standards for protection of the workers and public.

(Additional organizational structural detail, including commitments, relationships, responsibilities and authorities, will be contained in the Part B Preliminary Safety Analysis Report [PSAR] and the Final Safety Analysis Report [FSAR].)

2.1.1.1 Design and Construction Phase{tc \l4 "2.1.1.1 Design and Construction Phase}. Safety roles and responsibilities for the design and construction phase assigned to individuals and organizations within BNFL Inc. are discussed below. The organization is depicted in Figure 2-1. (The solid lines represent direct management and reporting responsibilities, while the dotted lines represent an interface other than a direct reporting responsibility.)



General Manager - The General Manager's roles and responsibilities are outlined below:

1) Having overall responsibility for safety
2) Defining safety policy, objectives, and interfaces
3) Assigning roles and responsibilities for safety-related activities
4) Setting performance expectations
5) Developing management assessment policies
6) Serving as chairperson of the TWRS-P Project Safety Committee (PSC)
7) Signatory on permit applications for construction of the TWRS-P Facility
8) Serving as a member of the BNFL Inc. Executive Committee.

Project Manager - The roles and responsibilities of the Project Manager include the following:

1) Managing overall design and construction effort

2) Implementing management assessment policies

3) Implementing the contractor requirements of the *Code of Federal Regulations* (CFR), 10 CFR Plant 820, AProcedural Rules for DOE Nuclear Activities@

4) Ensuring the development and implementation of the incident reporting program

5) Serving as the Emergency Director for events categorized as emergencies

6) Serving as alternate chairperson of the PSC

7) Approving final designs of Design Class I and II features.

8) Serving as principal interface with DOE on technical issues.

<u>Project Administration and Controls</u> - The roles of the project administration and controls organization include the following:

1) Implementing the Employee Concerns Program (ECP)

2) Implementing an employee feedback program

3) Controlling the facility policy manual (containing the General Manager=s safety policy) and all procedures

4) Developing and maintaining the records management program.

<u>Architect Engineering</u> - The architect engineering organization oversees the activities that are assigned to the architect engineer:

1) Updating the treatment process civil, architectural, structural, electrical, and mechanical design criteria

2) Completing the civil, structural, support system, and facility designs, including the incorporation of regulatory and quality commitments

3) Evaluating proposed changes to civil, structural, support system, and facility designs

4) Preparing specifications for procurement of equipment

5) Incorporating regulatory and quality commitments into the design, procurement, fabrication, inspection, and testing of systems and components

6) Designing measures to facilitate performance of technical safety requirement (TSR) and licensee controlled requirement (LCR) surveillance tests

7) Designing features to implement the design requirements of 10 CFR 835, AOccupational Radiation Protection,@ including ensuring that personnel exposure during operation is maintained as low as reasonably achievable (ALARA)

8) Selecting materials for fabrication and construction; defining methods for corrosion control; and specifying welding procedures, requirements for nondestructive examination, and codes and standards

9) Designing fire prevention, detection, and suppression features in compliance with state and Federal requirements

10) Incorporating deactivation and decommissioning features into the facility design.

Construction Management - The Manager of the construction management organization serves as a member of the PSC and as the Facility Manager during events categorized as incidents. The construction management organization provides an oversight function for the activities of the construction manager contractor. The construction manager contractor activities include the following:

1) Implementing procedures and training to enhance construction safety

2) Providing input to the configuration management program including as-built information

3) Supporting the incident reporting system for construction-related incidents

4) Developing procedures for handling hazardous material during construction, including packaging, labeling, storage, and shipping practices

5) Packaging and manifesting of dangerous waste arising from construction activities

6) Interfacing with subcontractors on process safety management and health, safety and environment matters

7) Incorporating regulatory and quality commitments of systems, structures, and components (SSCs) into the construction

8) Implementing the construction testing program to verify that SSCs meet acceptance testing requirements.

Technical - The manager of the Technical organization is a member of the PSC. The roles of the Technical organization include the following:

1) Updating the process hazards analysis for preparation of the FSAR
2) Ensuring that technologies are developed and demonstrated
3) Evaluating the completed process design and proposed changes to the design
4) Developing the objectives and scope for the startup program
5) Evaluating changes to the startup program
6) Identifying startup tests to be performed and their acceptance criteria

7) Writing nonradioactive and radioactive startup tests.

The Technical organization also oversees the following activities of the process designer:

1) Updating the process design specifications, process descriptions, and basis of design documents

2) Completing the process design, including incorporating regulatory and quality commitments

3) Incorporating regulatory and quality commitments into procurement, fabrication, inspection, and testing of process components

4) Performing systematic design reviews to determine readiness to authorize fabrication and construction of SSCs

5) Implementing design considerations for deactivation and decommissioning.

Configuration Management - The configuration management activities include the following:

1) Developing and implementing a configuration management system to control the safety and design basis

2) Obtaining documentation defining the physical configuration of the facility and forwarding this documentation to the Project Administration and Controls organization

3) Developing and implementing a configuration management database.

Operations and Technical Support - The roles of the Operations and Technical Support organization include the following activities:

1) Providing operator input to the design team during design and construction testing

2) Providing operator personnel support during design review meetings and test preparation and performance

3) Evaluating proposed changes to administrative controls related to facility operation

4) Developing and implementing the training programs required during the design and construction phase.

Environment, Safety, and Health (ES&H) - The Manager of the ES&H organization is a member of the PSC. The roles of the ES&H organization include the following:

1) Implementing internal safety and oversight functions

2) Developing safety basis and safety-related performance measures

3) Implementing the process safety management program

4) Evaluating proposed changes that involve implementation of nuclear, radiological, and process safety and environmental impact

5) Developing and implementing the regulatory commitment tracking system and the incident reporting program

6) Interfacing with regulatory stakeholders and Hanford Site contractors on health, safety and environment matters.

7) Coordinating cooperative agreements with outside agencies such as fire, police, ambulance, and medical services

8) Developing and managing the readiness review program to support startup.

Radiological, Nuclear, and Process Safety - This part of the ES&H organization oversees activities related to radiological, nuclear, and process safety. These activities include the following:

1) Identifying and evaluating new laws and regulations that may affect the TWRS-P Project safety programs

2) Preparing the Limited Work Authorization (LWA) request

3) Interfacing with the regulators during onsite inspections

4) Performing safety analyses and updating applicable documentation and reports.

Environmental Protection - This part of the ES&H organization oversees activities related to environmental protection. These activities include the following:

1) Preparing environmental reports

2) Identifying requirements for worker and public safety, security, and environmental regulatory compliance

3) Preparing the environmental characterization and monitoring plans

4) Preparing permit applications and plans as required for state and Federal environmental regulations

5) Monitoring environmental compliance during construction.

Quality Assurance (QA) - The manager of the QA organization is a member of the PSC. The roles of the QA organization include the following:

1) Developing and implementing the Quality Assurance Program (QAP) and the QAP Implementation Plan

2) Providing support for the development of qualification and training programs to ensure that required capabilities are achieved and maintained by project personnel

3) Assessing and auditing project activities to verify compliance with the QAP and other requirements and to determine the effectiveness of the QAP

4) Coordinating the project QAP interfaces with the functional organizations

5) Reviewing project documents (e.g., design documents, nuclear and process safety deliverables, work plans, and source evaluation plans) to verify inclusion of appropriate QAP requirements

6) Recommending and exercising work stoppage or controls over further processing in response to quality concerns

7) Assessing and auditing vendor and subcontractor activities to verify compliance with the QAP and other requirements and to determine the effectiveness of the QAP.

2.1.1.2 Operations Phase{tc \l4 "2.1.1.2 Operations Phase}. Safety roles and responsibilities for the startup, operations, and deactivation phase assigned to individuals and organizations within BNFL Inc. are discussed below. The organization is depicted in Figure 2-2. (The solid lines represent direct management and reporting responsibilities, while the dotted lines represent an interface other than a direct reporting responsibility.)

General Manager - The General Manager serves as the Chairman of the PSC. The General Manager=s safety responsibilities during facility operation and deactivation are the same as those identified in Section 2.1.1.1, ADesign and Construction Phase.@

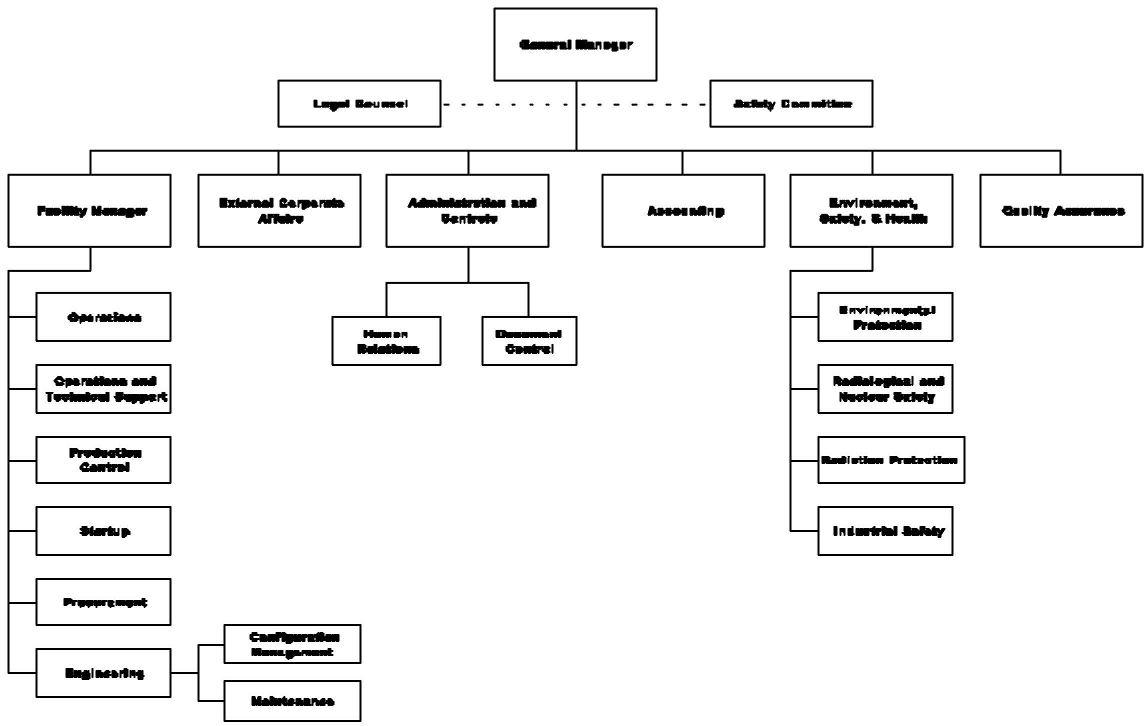
Facility Manager - The Facility Manager serves as the Deputy Chairman of the PSC. Responsibilities and roles of the Facility Manager include the following:

1) Ensuring the development and implementation of facility controls to protect the health and safety of workers and public and to protect the environment from hazardous situations associated with the chemical and radiological hazards of the facility

2) Ensuring that operational activities are properly staffed and controlled

3) Managing operation of the facility to meet production goals while maintaining the licensing basis for the facility

4) Approving TWRS-P Facility activities, including modifications to Design Class I and II SSCs



5) Ensuring that work is performed in conformance with procedures, policies, and safety requirements

6) Implementing the requirements of 10 CFR Part 820, AProcedural Rules for DOE Nuclear Activities@

7) Serving as the Emergency Director during events categorized as emergencies

8) Assigning roles and responsibilities for safety-related activities including operations, performance improvements, safety improvements, and deactivation of the facility.

Operations - The Operations Manager serves on the PSC. The roles of the operations organization include the following:

1) Developing a program for procedure preparation, review, verification, validation, approval, change, and deviation

2) Writing and maintaining operating procedures (including deactivation activities)

3) Maintaining a qualified staff and ensuring effective employee performance

4) Performing radioactive startup testing to demonstrate compliance with the acceptance criteria and documenting the results

5) Managing daily facility operation to meet production goals while maintaining compliance to the TSRs and LCRs

6) Performing TSR and LCR surveillance tests assigned to operations and supporting those TSR and LCR surveillance tests assigned to the Maintenance organization

7) Scheduling and managing process system outage activities

8) Initiating and managing deactivation.

Operations and Technical Support - Roles of the Operations and Technical Support organization include the following:

1) Evaluating proposed changes to the radioactive startup program

2) Developing and implementing the staff training program

3) Writing and evaluating proposed changes to administrative procedures related to facility operation

4) Ensuring operation of support systems (e.g., electrical, instrument air, and steam)

5) Performing analyses of feed material, product, and process chemicals

6) Developing procedures for hazardous material handling, packaging, labeling, storage, and shipping practices

7) Handling the packaging and manifesting of dangerous waste.

Environment, Safety, and Health - The Manager of ES&H serves on the PSC. Roles of the ES&H organization include the continuation of those responsibilities identified for the design and construction phase. In addition, for the operating and deactivation phases, the ES&H organization has the following roles:

1) Developing the emergency plan and the emergency plan implementing procedures

2) Managing emergency drills and exercises

3) Developing and implementing the safety improvement program that includes workers and management

4) Developing a deactivation plan that includes performance measures, modification of plans and procedures, and confirmation the facility meets the safe storage criteria on completion of deactivation

5) Managing occupational health and safety.

Environmental Protection - Roles of the Environmental Protection organization include the following:

1) Obtaining monitoring, sampling, and record keeping information on facility discharges

2) Maintaining state and Federal environmental permits

3) Maintaining the environmental database

4) Keeping environmental regulators informed on current status, concerns, and new data

5) Identifying critical aspects of facility deactivation that would affect environmental regulatory compliance.

Radiological, Nuclear, and Process Safety - Roles of the Radiological, Nuclear, and Process Safety organization include:

1) Monitoring compliance to the licensing basis

2) Developing the TSR and LCR surveillance testing and evaluation program

3) Developing a process for evaluating deficiencies to nuclear safety requirements subject to 10 CFR 820, AProcedural Rules for DOE Nuclear Activities@

4) Updating licensing basis documentation including the FSAR

5) Implementing the unreviewed safety question (USQ) evaluation process.

6) Directing incident investigation program activities that include reporting, performing root cause analyses, identifying corrective actions, tracking the effectiveness of corrective actions, and applying lessons learned from relevant facilities

7) Preparing a deactivation safety analysis report.

Radiation Protection - Roles of the Radiation Protection organization include the following:

1) Developing and implementing the Radiation Protection Program in compliance with 10 CFR 835, AOccupational Radiation Protection@

2) Performing radiation and contamination surveys and maintaining personnel exposure records

3) Informing the ES&H Manager and the Facility Manager of conditions that could cause exceeded radiation limits established for radiation areas or exceeded administrative limits for personnel radiological exposure

4) Monitoring deactivation activities to ensure personnel exposure meets ALARA limits.

Quality Assurance - The QA Manager is a member of the PSC. Roles of the QA organization include the following:

1) Establishing a QAP and the Implementation Plan for operations and for deactivation

2) Performing independent assessments and compliance audits

3) Reviewing and documenting concurrence with operating procedures and work instructions

4) Implementing stop work for QA violations and unsafe conditions

5) Verifying implementation of corrective action measures and determining that the solutions for quality problems are effective.

Engineering - The Engineering Manager is a member of the PSC. Roles of the Engineering organization include the following:

1) Evaluating startup test results and comparing the results to acceptance criteria

2) Developing and evaluating proposed design improvements and changes to engineered features

3) Supporting resolution of production problems

4) Developing the surveillance and maintenance criteria for facility operations

5) Identifying measures that minimize hazards associated with treating and storing radioactive liquid, solid waste, and fissionable materials

6) Performing a job hazard analysis and participating with ES&H to update the Hazard Analysis Report (HAR)

7) Updating the process hazards analysis (PHA) to support permit and license updates

8) Preparing and implementing a deactivation management plan that includes updating the HAR, defining surveillance and maintenance criteria for deactivation and safe storage, developing facility modifications to facilitate performance of surveillance tests, and implementing measures that minimize hazards associated with treating and storing radioactive materials.

Maintenance - Roles of the Maintenance organization include:

1) Defining, implementing, and maintaining a maintenance program based on vendor recommendations and equipment history

2) Writing maintenance procedures

3) Performing TSR and LCR surveillance tests assigned to maintenance and supporting those TSR surveillance tests assigned to operations

4) Implementing facility modifications

5) Developing and modifying maintenance instructions for equipment

6) Collecting safety component and processing baseline data for performance of monitoring and maintenance planning

7) Using safety component and process baseline data for future performance monitoring and maintenance planning.

Startup - The Startup organization manages the nonradioactive startup testing program. Additional roles of the Startup organization include the following:

1) Evaluating proposed changes to the program

2) Verifying and validating operation and maintenance procedures during performance of testing

3) Providing information from the startup program to the operations support and training and procedures organizations, and providing maintenance for verifying and validating operating administrative controls.

Configuration Management - Configuration management activities include the following:

1) Continuing the implementation of configuration management
2) Maintaining the facility operating history to facilitate deactivation of the facility.

Administration and Controls - The Administration and Controls organization continues those activities started by the Project Administration and Controls organization during the design and construction phase (see Section 2.1.1.1, ADesign and Construction Phase@).

2.1.2 Management Controls{tc \l3 "2.1.2 Management Controls}

Administrative policies and procedures control the interactions among major facility activities through the integration of safety management into work planning and performance. Such integration protects workers, the public, and the environment by implementing work practices that never compromise safety for the sake of production or expediency. The sections describing the management controls implemented for TWRS-P Project programs are listed below.

1) Section 3.11, AOperational Practices,@ describes conduct of operation practices and policies.

2) Chapter 9.0, AEmergency Management,@ describes the emergency plan.

3) Section 3.7,AIncident Investigations,@ describes the process for reporting potentially unsafe or nonconforming conditions, activities, or events; and investigating, evaluating, and reporting the incident or concern.

4) Section 3.3, AQuality Assurance,@ describes the implementation of the QA program.
5) Section 3.8, ARecords Management,@ discusses document control.

6) Section 3.1, AConfiguration Management,@ discusses the configuration management process.

7) Section 3.4, ATraining and Qualification,@ describes the training and qualification program.

8) Section 3.6, AAudits and Assessments,@ discusses the performance, review, and resolution of audits and assessment.

BNFL Inc. integrates safety management into work planning through the following processes:

1) Assignment of a qualified person for overall responsibility for the development implementation, and integration of the safety management process

2) Conducting activities in an atmosphere of trust and confidence based on open, honest, and responsible communication

3) Encouraging employee feedback

4) Using proven and effective approaches to risk identification and control

5) Conducting business with integrity and mutual respect for employees and interfacing organizations

6) Applying a systematic approach to activities that affect health, safety, and environment

7) Establishing clear ownership and accountability

8) Defining and reaching agreement with the employees on the work to be accomplished by the facility operation and the expectation to accomplish the work in a safe manner

9) Promoting teamwork through involvement of knowledgeable parties

10) Empowering employees to effectively protect themselves, the public, and the environment

11) Allocating appropriate resources to support health, safety, and environment activities

12) Supporting continuous improvement of health, safety, and environment performance

13) Managing and conducting a consistent and project-wide integrated approach to safety for all activities

14) Encouraging and promoting the sharing of information and resources.

Application of the above work practices allows the BNFL Inc. team to effectively implement guiding principles for integrating safety management into work planning and performing. These guiding principles include establishing line management responsibility for safety, establishing lines of authority, ensuring that personnel have the necessary qualifications to perform the work, providing effective allocation of resources, performing pre-work hazard assessments, establishing appropriate controls for hazards and hazardous situations, and establishing operational requirements.

These work practices and principles are an integral part of the BNFL Inc. team's safety culture and are formalized in TWRS-P Project policies.

2.1.2.1 Line Management Responsibility for Health, Safety and Environment{tc \l4 "2.1.2.1 Line Management Responsibility for Health, Safety and Environment}. Line management responsibility and accountability for health, safety, and environment are key principles of the BNFL Inc. approach to health, safety, and environment integration. To ensure maximum effectiveness in health, safety, and environment performance, employees are informed of their responsibilities and accountabilities for creating and maintaining a safe and healthy workplace and protecting the environment.

In addition, individuals in the ES&H organization assume roles that are independent of the line organization. This creates an environment where accountability is clearly focused and health, safety and environment priorities are never sacrificed to a line mission or objective.

2.1.2.2 Lines of Authority and Responsibility{tc \l4 "2.1.2.2 Lines of Authority and Responsibility}. Clear and unambiguous lines of authority and responsibility are established throughout the TWRS-P Project through its design, construction, operation, and deactivation phases. The flowdown of health, safety, and environment responsibility and accountability starts with the General Manager and extends through the management and supervisory chain to each worker, irrespective of the type of work being performed. This flowdown is captured in policies and procedures, communicated to the workforce through orientation and training, reinforced by group and individual performance evaluations, and monitored and assessed by independent oversight.

Stop-work authority also flows down from managers to individual workers who are empowered to halt any activity in which they are engaged that is unsafe or potentially harmful to the workers, the public, or the environment.

2.1.2.3 Personnel Qualification and Resources{tc \l4 "2.1.2.3 Personnel Qualification and Resources}. The TWRS-P Project training provides personnel with the knowledge, skills, and direction necessary to perform their duties in a safe and environmentally sound manner. Training requirements are established based on a tailored approach, commensurate with the level of risk and individual responsibility.

One component of the TWRS-P Project training addresses relevant health, safety, and environment requirements, including the following:

1) Employees are trained to ensure that they recognize, understand, and anticipate the hazards and the environmental requirements associated with performing their work.

2) Supervisors are trained to ensure that they understand their responsibilities for assisting employees in analyzing the work for safety hazards and environmental compliance requirements; to assist employees in maintaining physical protection at work sites; and to enforce (and reinforce) performance standards, protective measures, and environmental practices.

3) Managers are trained to understand their responsibilities for providing necessary health, safety, and environment support and direction to supervisors, employees, and subcontractors and for demonstrating health, safety, and environment leadership through their actions and communications.

Resources are assigned to ensure that protection is provided for workers, the public, and the environment. The risk assessment process, discussed in Section 4.6, AIntegrated Safety Assessment Methods,@ provides the key input to the resource allocation process by identifying the significant risks associated with TWRS-P Facility work activities.

2.1.2.4 Hazard Assessments, Controls, and Operating Conditions{tc \l4 "2.1.2.4 Hazard Assessments, Controls, and Operating Conditions}. The performance of hazard assessments, the selection of appropriate controls, and the establishment of safe operating conditions are achieved through evaluations that ensure the identification of significant risks. The TWRS-P Facility tasks and the work environment are evaluated to identify hazardous situations, conflicts, and other conditions that may significantly affect the health, safety, or efficiency of the BNFL Inc. employees. Each of the following basic components of the system is performed with a degree of rigor based on the scope of the work effort and commensurate with the potential hazardous situation presented.

1) Pre-job planning encompasses the task description, required personnel skills, expected hazards and hazardous situations, protection methods, anticipated exposure levels, waste generation, and emergency response.

2) Baseline evaluations determine the status of a facility area or system.

3) Integrated hazard analyses detail the evaluations of the potential hazards and the controls needed to protect workers, the public, and the environment.

4) Radiological work planning outlines routine and special radiological controls, precautions, surveillance tests, and instructions to personnel, as well as prerequisite conditions (e.g., tagouts and system isolations).

5) Audits and assessments verify that specific elements of the BNFL Inc. policies are being effectively implemented, that work is being performed safely, and that appropriate compliance and commitment tasks are being performed.

6) BNFL Inc. examines work-related injuries or illnesses, near misses, motor vehicle accidents, property damage, environmental spills and releases, fires, and explosions through accident and incident response to identify the root cause and contributing causes of the event and the corrective actions necessary to prevent recurrence.

The above safety management processes provide an integrated and formalized methodology to ensure that the risks associated with potential health, safety, and environmental hazards and hazardous situations are identified and properly addressed, and that the TWRS-P Facility is operated safely and in compliance with environmental regulations.

2.2 SAFETY COMMITTEES{tc \l2 "2.2 SAFETY COMMITTEES}

The TWRS-P PSC structure provides the overview, review, and approval functions for nuclear, radiological, and process safety, occupational safety, and environmental protection matters. The BNFL Inc. Executive Committee addresses corporate safety policies and matters as they relate to BNFL Inc. Projects (i.e., the TWRS-P Project). The TWRS-P Facility PSC addresses TWRS-P Facility-specific safety policies and regulatory requirements. This two-tier structure affords open communications and sharing of relevant information between the BNFL Inc. corporate staff, international operations, and the TWRS-P Project.

During the design and construction phase, the BNFL Inc. Executive Committee and the TWRS-P Facility PSC focus on nuclear, radiological, and process safety (as related to the development of the facility design and operations) and on worker safety (as related to construction activities). As the construction phase nears completion, the safety committees' focus shifts to startup activities and preparations by the various TWRS-P Project organizations to ensure the effectiveness of their nuclear and worker safety programs during operation. During operation, the committees focus on operations, management, performance of personnel, equipment, and systems, and incidence reporting. Near the end of waste processing operations, radiological control and worker safety during deactivation are also addressed.

2.2.1 BNFL Inc. Executive Committee{tc \l3 "2.2.1 BNFL Inc. Executive Committee}

The BNFL Inc. Executive Committee provides independent oversight and review of TWRS-P Project matters that affect nuclear, radiological, and process safety; occupational safety; and environmental protection. The membership comprises BNFL Inc. Chief Operating Officer; Vice President of Environment, Safety, and Health; other senior vice presidents; and the TWRS-P Facility General Manager. *(The charter of the committee, including information related to the roles, authorities, specific composition, member qualifications, quorum requirements, and meeting frequencies will be established during Part B and will be included in the PSAR.)* To accomplish its objective, the Executive Committee periodically reviews areas such as:

1) Safety programs that implement BNFL Inc. policy and regulatory requirements applicable to the TWRS-P Project

2) Recommendation of the approval to proceed with hot operations

3) The significance of new regulations applied to BNFL Inc. TWRS-P Project programs, procedures, and policies

4) Unusual and off-normal incident reports

5) Reports and meeting minutes issued by the PSC

6) The effectiveness of TWRS-P Project safety programs and associated management controls.

The Executive Committee also initiates special independent assessments or audits, as necessary, to obtain additional information concerning the effectiveness of programs or management controls at the TWRS-P Project.

2.2.2 TWRS-P Project Safety Committee{tc \l3 "2.2.2 TWRS-P Project Safety Committee}

The PSC provides advice to the TWRS-P Project General Manager on matters related to safety. The membership comprises facility managers from organizations such as ES&H, QA engineering, and operations, in addition to specialists in specific fields and external members. The members are specified from several different organizations and backgrounds to ensure that the advice provided to the General Manager is representative of an integrated evaluation of the matters under consideration. *(The charter of the PSC, including information related to roles, authorities, the specific composition, member qualifications, quorum requirements, and meeting frequencies will be established during Part B and included in the PSAR.)*

The PSC reviews the management and the performance of the TWRS-P Facility nuclear, radiological, process, and occupational safety and environmental protection activities, including the following:

1) Results from the Safety Improvement Program, lead by ES&H

2) Identification, resolution, and implementation of recommendations and corrective actions resulting from nonconforming items or activities, incident investigations, audits and assessments, inspections and reviews, or emergency exercises

3) Unusual and off-normal incident reports, including TSR and LCR violations

4) Reports covering such topics as proposed TWRS-P Facility modifications, emergency exercises, and the implementation of findings from management assessments

5) Performance indicators and trends of the TWRS-P Facility for worker, public, and environmental safety activities

6) Results of training programs for safety-related activities

7) Operating problems

8) Responses to Notices of Violations from the regulator.

The PSC is also responsible for the reviewing and recommending approval to the General Manager for the following safety-related documents:

1) TWRS-P Facility startup testing and preoperational testing programs, including test procedures and test result summaries

2) Operating plans and procedures

3) Proposed changes to the emergency plan

4) Proposed changes to the TSRs, the LCRs, and the Safety Criteria of the Safety Requirements Document

5) Proposed Design Class I and II design changes

6) Positive USQ determinations prior to submittal to the regulator

7) Audit and assessment reports.

3.0 CONDUCT OF OPERATIONS{tc \l1 "3.0 CONDUCT OF OPERATIONS}

Management controls and programs direct the operations of the Tank Waste Remediation System-privatization (TWRS-P) Facility. These controls and programs provide expectations and the descriptions of processes to be used to achieve the goals. The programs cover areas as diverse as design to operational practices and are discussed in further detail in the following sections.

3.1 CONFIGURATION MANAGEMENT{tc \l2 "3.1 CONFIGURATION MANAGEMENT}

Configuration management for nuclear, radiological, and process safety of the TWRS-P Facility maintains consistency between design requirements, physical configuration, and facility documentation. Configuration management facilitates maintaining the safety envelope of the facility and the operability of the structures, systems, and components (SSCs). BNFL Inc. uses a tailored approach for the configuration management of the design basis throughout the lifecycle of the TWRS-P Facility.

BNFL Inc. controls changes to the configuration of the TWRS-P Facility technical baseline relating to areas such as the Hanford Site, safety analyses, SSCs, procedures, training; and computer software. The need for changes to engineered features or administrative controls can arise from startup testing, human factors reviews, corrective actions identified by the incident investigation process, the internal oversight process and the performance of assessments, the lessons learned program, employee feedback program, performance of emergency drills and exercises, the need to improve the waste process operation, and the continuous review of worker and public safety. Facility personnel develop, review, implement, and document changes in accordance with the configuration management procedures. Implementation of these procedures ensure that a high level of protection is maintained for the workers, the public, and the environment. The unreviewed safety question (USQ) evaluation ensures that, when necessary, the proposed changes are not implemented until the appropriate regulatory approvals have been obtained.

The basic elements used to maintain the configuration of the TWRS-P Facility include the following:

1) Identification of the need to change engineered features or administrative controls

2) Development, approval, and installation of modifications

3) Training the staff affected by modifications (see Section 3.4, ATraining and Qualification@)

4) Revision of the operational, test, calibration, surveillance, and maintenance procedures (see Section 3.9, AProcedures@)

5) Control of replacement parts

6) Post-modification testing

7) Management and independent assessments.

(Section 3.1, AConfiguration Management,@ will be expanded in the Preliminary Safety Analysis Report [PSAR] and Final Safety Analysis Report [FSAR] to contain more specific information on 1) controls used to maintain configuration management of the TWRS-P Facility; 2) scope of identified SSCs and relationship of the SSCs to contents of Chapter 4.0, AIntegrated Safety Analysis;@ 3) description of the contents of design information packages to be provided to the safety analysts; 4) change control system specifics, including identification, technical and management reviews, documentation, and implementation; 5) post-modification testing, programmatic and physical configuration assessment specifics, and periodic equipment performance monitoring; 6) development and installation of modifications; 7) organizational structure and staffing interfaces including training of affected staff; 8) control of revisions to operating, test, calibration, surveillance, and maintenance procedures and drawings; 9) selection and control of replacement parts; and 10) description of the process for establishment and documentation of the TWRS-P Project design requirements and design basis.)

3.1.1 Program Management{tc \l3 "3.1.1 Program Management}

The TWRS-P Project technical organization is responsible for developing and maintaining the process used for configuration management. A number of factors that include the critical nature of the project mission, the size and complexity of the overall project, the importance of configuration management to facility safety, the number of affected organizations, and the investment of resources, make configuration management an important part of the TWRS-P Project. The configuration management process accomplishes the following:

1) Implements activities to document, catalog, and maintain design requirements and design basis (see Section 3.8, ARecords Management@)

2) Implements a complete and integrated system to carry forward the safety and design bases established in the design and construction phase into the operations and deactivation phases

3) Provides as-built physical configuration and design information documentation needed to support operability evaluations

4) Supports the design process that provides control of design inputs, outputs, verification, configuration, and design changes as required by applicable quality assurance (QA) requirements

5) Supports the inspection and test process to identify the status of SSCs requiring examination to ensure that failed or untested SSCs are not used

6) Support the evaluation of proposed changes, as well as nonconforming and degraded conditions

7) Supports the resolution of critical design and operational problems by facilitating timely identification and retrieval of complete and accurate information.

Configuration management affects many organizations and disciplines, such as design engineering, operations, maintenance, testing, training, procurement, and document control.

Input for the initial development and subsequent revisions to the configuration process or implementing procedures is provided by the affected organizations.

The Technical organization is responsible for implementing the procedure by which proposed changes, tests, and experiments are reviewed in the USQ evaluation process.

The TWRS-P Project Administration and Controls Manager is responsible for ensuring that documentation required to define the physical configuration, the design information, and the procedures used to maintain the physical configuration consistent with the design requirements are maintained safely and securely. The documentation is also legible and retrievable in a timely manner to ensure that the TWRS-P Project configuration is maintained (see Section 3.8, ARecords Management@).

The TWRS-P Project Technical organization ensures that the design information (e.g., design requirements, including safety criteria design basis, performance requirements, regulatory requirements, codes, standards, environmental conditions, and interfaces) is maintained current and accurate.

Each organization responsible for a portion of the TWRS-P Facility ensures that the portion of the physical configuration that falls under its jurisdiction is modified, operated, and maintained consistent with the design information reflected in TWRS-P Facility specifications, drawings, instructions, and procedures.

The TWRS-P Facility employees involved in waste-processing operations or handling hazardous materials are responsible for ensuring that actions that would change the physical or procedural aspects of the TWRS-P Facility (e.g., during operation, maintenance, or modification activities) so the facility would be placed outside of the licensing basis.

The design classification of SSCs is based on the results from the accident analysis process, as discussed in Chapter 4.0, AIntegrated Safety Analysis.@ The TWRS-P Project configuration management is applicable to Design Class I and II SSCs, as defined in Section 3.3.5, AGraded Quality Approach.@ Configuration management system is applied to Design Class III SSCs using a tailored approach. The tailored application is dependent on risk to the mission and consequences of SSC failure to ensure increased reliability, investment protection, or to satisfy other project performance criteria, as stated in Section 3.3.6, AApplication of Graded QA to SSCs, Processes, and Activities.@

The responsibilities for the identification, evaluation, and implementation of changes to the TWRS-P facility are identified in Table 3-1. The characteristics of the configuration management process include the following elements:

1) Identification - Identification of proposed changes initiated by individuals or project organizations who determine that a departure from the technology of the process, the facility design, or operating procedures is warranted.

2) Evaluation - After identification, the TWRS-P Project (*position title determined later)* evaluates the potential impact on safety, the impact on the facility mission, and the schedule and cost of the proposed change.

Table 3-1. Responsibilities for Changes to the TWRS-P Facility

Change	During Design and Construction	During Operation
Civil/structural design or a support systems (e.g., mechanical and electrical systems)	Architect Engineering	Engineering
Waste processing	Technical	Engineering
Facility operation, not related to startup testing	Operations Support	Operations Support
Startup program, non-radioactive	Technical	Startup
Startup program, radioactive	Technical	Operations Support
Nuclear, radiological, and process safety	Radiological, Nuclear, and Process Safety	Radiological, Nuclear, and Process Safety
Environmental	Environmental Protection	Environmental Protection

Factors considered in this evaluation include potential impact on facility performance, continued compliance with regulations, impact on design and licensing basis, applicable codes and standards, programmatic risk significance, and funding. Configuration management, QA, onsite review committee approvals, and procedures play important roles in assuring an integrated and adequate review of all changes so safety is maintained.

The impact of the proposed change on the design and licensing basis is evaluated in accordance with the USQ process with input from the functional areas of design, configuration management, licensing, operations, and safety.

3) Approval - The approval process is consistent with the process applied to the original configuration so the change is approved by the same (or equivalent level) organization that approved the original configuration. Regulatory authorization is obtained, as required.

4) Implementation - After the change is approved and authorized by the TWRS-P Project regulator, if required, the change is implemented. Associated documentation is modified, in accordance with procedural requirements, to reflect the changes that were implemented.

The U.S. Department of Energy regulatory unit (DOE-RU) approval is obtained prior to completion of a proposed action that involves a change in the TSRs or creates a USQ. However, preparation of documentation, completion of design, and SSC procurement or fabrication can proceed, at risk, while a request for USQ approval is being prepared and the DOE-RU review is underway, provided that these activities do not create a USQ. Installation of the SSC can also be completed as long as the installation itself does not result in a USQ.

An action is not initiated if the initiation itself would result in a USQ; in some cases, the installation process or presence of the installed equipment would result in a USQ and for other cases, the USQ would only result when the equipment is placed in service.

Achieving an effective interface between vendors and subcontractors and the TWRS-P Project is an important aspect of effective TWRS-P Project configuration management. Vendors and subcontractors performing work in support of the TWRS-P Project either employ existing or develop new procedures for implementation of configuration management. It is the responsibility of designated TWRS-P Project staff to review and approve vendor and subcontractor configuration management practices to ensure compliance with the TWRS-P Project configuration management requirements.

Facility procedures that implement requirements and processes, such as operation, test, calibration, surveillance, and maintenance are developed, approved, and modified in accordance with the configuration management process. Designated members of the TWRS-P Facility staff coordinate the identification, development, and subsequent modification of implementing procedures, as necessary.

A database covering the SSCs governed by configuration management is under the administrative control of the TWRS-P Technical Manager. The database relates applicable design information and requirements to their implementing SSCs and appropriate, associated documentation. The interrelational nature is such that proposed or identified changes to the controlled design, configuration, or documentation identifies other affected design, configuration, or documentation entities for which consideration of acceptability of the change must be addressed. Acceptance of the proposed change is not sanctioned in the database until reconciliation is achieved.

The TWRS-P Facility staff responsible for implementing portions of configuration management process, or who are responsible for changes to the TWRS-P Facility physical configuration, design, or documentation subject to conformance with the configuration management process, are provided training for those activities. In addition, TWRS-P Project vendors or subcontractor personnel responsible for implementing portions of the program configuration management process are qualified *(qualification requirements to be developed in Part B)* to use applicable TWRS-P Project systems and processes.

Management assessments are performed periodically to evaluate the effectiveness of configuration management and initiate corrective actions, as needed, to improve performance. In addition, the QA organization determines, through performance of periodic audits, surveillances, and assessments, the effectiveness of configuration management functions and identifies deficiencies. The TWRS-P Facility Configuration Management organization is responsible for preparing and revising the TWRS-P Project configuration management process to ensure that deficiencies are corrected through appropriate program upgrades. See Section 3.6, AAudits and Assessments,@ for additional details.

3.1.2 Design Requirements{tc \l3 "3.1.2 Design Requirements}

Design requirements are established for each of the SSCs identified as governed by the TWRS-P Project configuration management process. The requirements include the conditions under which the equipment must function during accident conditions (e.g., load, pressure, voltage, temperature,

radiation field, and humidity). The bases for design requirements for the SSCs are documented and included in the database described in Section 3.1.1, AProgram Management.@ A description of the establishment of the facility design requirements and design bases is included in the database and is controlled as part of configuration management.
Suitable hazard and accident analysis methods, including controlled computer codes, are used to evaluate safety margins of the original design and the proposed design changes. Boundaries of the design requirements for the systems or processes are identified on controlled engineering documentation in such a manner that a unambiguous determination of the physical and process limits is possible.

3.1.3 Document Control{tc \l3 "3.1.3 Document Control}

The TWRS-P Project requires availability and retrievability of accurate documentation to support safe, sound, and timely decision making related to facility design and operations. This requirement is met by maintaining configuration management. Configuration management supports the high-efficiency level of the TWRS-P Facility by ensuring the availability of needed information, by helping to prevent errors and the resultant rework, by reducing duplication of effort, and by improving scheduling and planning estimates.

The document control process, as described in Section 3.8, ARecords Management,@ supports the configuration management process. This process ensures 1) that documentation exists that is required to define the physical configuration; 2) the design information is maintained; and 3) the procedures employed to maintain the physical configuration consistent with the design requirements, licensing, and design basis, are controlled, maintained safely and securely, and available in a timely manner to ensure integrity of the overall TWRS-P Project configuration. These documents include:

1) Design requirements

2) Safety Requirements Document (SRD)

3) Safety Analysis Reports (SAR)

4) Safety Evaluation Reports (SER)

5) TSRs and Licensee Controlled Requirements (LCRs)

6) Design, maintenance, operating, training, QA, audit, surveillance, assessment, and emergency operating procedures

7) As-built drawings

8) Specifications

9) Emergency response plans

10) Facility modification documents.

Following initial approval, the identified documents are placed under change control. The TWRS-P Facility staff ensure that the lists of the documents are maintained current, master copies of the documents are maintained in a safe and controlled manner, and revisions are distributed to the necessary points in a timely manner.

Configuration management document lists identify the latest approved version of the individual documents, the document owner, the document custodian, and information relating to change status. Changes to documents subject to the configuration management controls are completed in accordance with established processes. The configuration management process also controls and maintains accurate as-built drawings during the contract life of the TWRS-P Facility.

3.1.4 Change Control{tc \l3 "3.1.4 Change Control}

A number of conditions can lead to a need to change the physical configuration, design information, or system documentation. Such changes could be triggered by, but not limited to, design changes, corrective action(s) resulting from a deficiency, and manufacturing or process changes. Changes to the documentation may also require a change to the SAR to ensure that it accurately represents the status of the TWRS-P Facility. Changes to the TWRS-P Facility physical configuration, design information, and program documentation are implemented in accordance with the configuration management process to ensure continuing integrity of the configuration.

3.1.4.1 Unreviewed Safety Question{tc \l4 "3.1.4.1 Unreviewed Safety Question}. The USQ evaluation process allows the TWRS-P Project management to make changes to the facility, the procedures, and the license basis documents and to conduct tests and experiments at the TWRS-P Facility without prior DOE-RU approval, provided the activity does not involve a change to the TSRs or a USQ. A proposed change, test, or experiment involves a USQ, 1) if the probability of occurrence or the consequences of an accident or the malfunction of equipment important to safety previously evaluated in the SAR may be increased, 2) if a possibility for an accident or malfunction of a different type than any evaluated previously in the SAR may be created, or 3) if a margin of safety as defined in the basis for a TSR is reduced.

After operations at the TWRS-P Facility are authorized, proposed changes to the engineered or administrative controls that can affect safety are assessed to determine if a USQ evaluation or a change to a TSR is required. A proposed change that does not involve a USQ or a TSR can be implemented without the approval of the regulator. If a USQ is identified or a change to a TSR is needed, one of the following three options are pursued:

1) The proposed activity is abandoned.

2) The proposed activity is modified to obviate the USQ.

3) The proposed activity is submitted to the regulator for review and approval prior to completion of the activity.

The existence of a nonconforming and degraded condition does not automatically require a USQ evaluation. However, a USQ evaluation is required if the condition or the implementation of the resolution for the condition is a change to the facility that potentially creates one of the conditions cited above.

To complete a USQ evaluation, the license basis documents are reviewed to determine the impact of the change, test, or experiment on the safety analyses performed. A USQ evaluation is performed for changes to the facility SSCs or procedures, or for tests and experiments that are described in the licensing basis. The activities are discussed in further detail in the following sections.

3.1.4.1.1 Temporary or permanent changes to the TWRS-P Facility as described in the licensing basis{tc \l5 "3.1.4.1.1 Temporary or permanent changes to the TWRS-P Facility as described in the licensing basis}. A change is a permanent or temporary modification or replacement of a feature of the TWRS-P Facility with one that is not equivalent to the original in the design requirements. Examples of changes include jumpers and lifted leads, temporary shielding on pipes and equipment, temporary blocks and bypasses, temporary supports or other equipment used on a temporary basis. Additions (e.g., new systems or structures) and subtractions (e.g., abandoning a system or component in place) are also considered to be changes for purposes of determining if the facility is changed.

Changes to SSCs not explicitly described in the licensing basis are also reviewed because they have the potential for affecting the function of SSCs that are explicitly described.

Changes that alter the design, function, or method of performing the function of an SSC, as described in the licensing basis, are within the scope of the USQ evaluation process.

3.1.4.1.2 Temporary or permanent changes to TWRS-P Facility procedures{tc \l5 "3.1.4.1.2 Temporary or permanent changes to TWRS-P Facility procedures}. Procedures within the scope of the USQ process include operating, chemistry, system, test, surveillance, and emergency procedures that specifically implement provisions of the licensing basis.

Activities or controls over functions, facility configuration, task reviews, tests, or safety review meetings that are described or defined in the licensing basis and are within the scope of the USQ evaluation process.

Changes that result in system operation in a way that deviates from the system operation described in the licensing basis (in words or drawings) are within the scope of the USQ evaluation process.

3.1.4.1.3 TWRS-P Facility tests or experiments not described in the existing licensing basis{tc \l5 "3.1.4.1.3 TWRS-P Facility tests or experiments not described in the existing licensing basis}. A test or experiment is a special procedure for a particular purpose or an evolution performed to gather data. A test or experiment not described in the licensing basis documents (that potentially impacts SSCs or processes described in the licensing basis) is evaluated to determine if a TSR change or USQ is involved.

3.1.4.1.4 Changes to a system or component as described in the licensing basis{tc \l5 "3.1.4.1.4 Changes to a system or component as described in the licensing basis}. The changes to license basis documentation are within the scope of the USQ process. In addition, differences between the facility and the corresponding description in the license basis are defacto changes that are within the scope of the USQ evaluation process.

3.1.4.2 Design Change Packages{tc \l4 "3.1.4.2 Design Change Packages}. A design change application (DCA) is developed to identify, communicate, record, and control a proposed design change that requires a physical modification to the facility. The DCA also initiates a review across relevant engineering design disciplines to determine the potential impact of the change on the TWRS-P Facility. A DCA is required for both additions and deletions to the design and addresses the effect on safety. The DCA includes the following components:

1) A statement of the design change
2) Safety category and justification
3) A list of key design documentation affected
4) An examination of each functional area (e.g., safety, process)
5) A statement of external effects
6) A statement of the effect on facility safety, reliability, operability, and maintainability
7) A safety assessment
8) Potential environmental permit implications
9) Potential contract, mission, and schedule and cost implications
10) Safety committee recommendations.

Review by the TWRS-P Project engineering staff ensures that the design and licensing basis and design requirements are consistent and not compromised; that safety and mission-affecting requirements are identified; that acceptance testing, operational, and maintenance specifications are developed; and that affected or interfacing SSCs and documentation, including the SAR, TSRs, and LCRs, are modified or reconciled.

A Design Change Notice (DCN) is used to communicate and control changes that only affect documentation to ensure that the impacts of the changes are identified and assessed prior to implementation.

Prior to implementation, technical and management review meetings are conducted by the TWRS-P Project Technical organization to ensure that proposed changes are acceptable. If approved, implementation is directed by the change package. Field changes are subject to review and approval equivalent to that identified on the original change package.

Operations and maintenance procedures, including personnel training on the procedures, are prepared and approved for use in the field prior to acceptance of the modified SSCs. Post-modification testing is performed on the installation to verify conformance with the acceptance test specifications and test procedures derived from the acceptance test specifications. As-built drawings and specifications are completed in compliance with procedural requirements.

Procurement of replacement parts for Design Class I and II and specific Design Class III SSCs are subject to QA program controls, prescribed codes and standards, and technical requirements equal to or greater than the original technical requirements, or as required to prevent the procurement of defective parts (see Section 3.3.6, AApplication of Graded QA to SSCs, Processes, and Activities@). Inspections and acceptance testing of replacement parts are performed in accordance with established acceptance and performance criteria to demonstrate that the replacement parts perform satisfactorily.

Documentation for the change control activities is reviewed and approved for release in a manner equivalent to the review and approval process required for the original design. Completed change control documentation is entered into the configuration management database.

3.1.5 Assessments{tc \l3 "3.1.5 Assessments}

Audits and assessments of the configuration management process are documented and used to determine effectiveness of the process and to identify potential improvements or deficiencies. (See Section 3.6, AAudits and Assessments.@)
An important goal of configuration management is to support the readiness review required for the Operating Authorization Request. BNFL Inc. involves the TWRS-P Project regulator in all aspects of the configuration management process to facilitate this Operational Authorization Request.

3.2 MAINTENANCE{tc \l2 "3.2 MAINTENANCE}

The TWRS-P Facility maintenance program ensures that the reliability and effectiveness of facility Design Class I and II SSCs remains in accordance with design requirements and that the safety status of the facility is not adversely affected by maintenance activities. The Design Class I and II SSCs and human actions relied on for protection of workers and the public, and the respective maintenance and surveillance actions assigned to these SSCs and related activities are included in the program. The analysis process that identified these SSCs and related activities as being required to prevent or mitigate the consequences of radiological or chemical releases is described in Section 4.8, AControls for Prevention and Mitigation of Accidents.@ The rationale associated with the selection and scheduling of the maintenance and TSR surveillances associated with these SSCs and human actions is also discussed in Section 4.8.

In addition to the maintenance and surveillance activities identified in Section 4.8, AControls for Prevention and Mitigation of Accidents,@ additional maintenance activities are included in the maintenance program to support reliable facility operation and to protect investments. The application of maintenance policies and procedures to a particular facility item are based on design classification (as described in Sections 4.6, AIntegrated Safety Assessment Methods@), on BNFL and industry equipment history, and on best engineering judgment.

The BNFL Inc. design incorporates numerous features to minimize the need for replacement or overhaul activities and to minimize the amount of hands-on maintenance of equipment that is exposed to radioactive or potentially radioactive material. These design features are based on lessons learned during BNFL=s 30 years of experience operating processing facilities such as BNFL Sellafield Site and include:

1) The use of specially designed, high-integrity remotely removable and replaceable pumps and valves in process systems

2) The use of equipment with no moving parts, (e.g., air lifts, ejectors, fluidic pumps, and reverse flow diverters)

3) The duplication of equipment and process lines

4) The ability to empty vessels and the provision of in-vessel wash systems

5) The use of modular facility design and the ability to remove equipment to designated decontamination and maintenance areas

6) The positioning of in-cell maintainable equipment within shielded access areas

7) The choice of long-lived construction materials and of the dimensions and thickness of vessels and piping to minimize the possibility of failure during facility life

8) The application of appropriately designed tools and equipment.

Personnel with maintenance experience are integrated with the BNFL Engineering Ltd. and GTS Duratek design organizations to influence a final TWRS-P Facility design that reflects current industry knowledge on implementation of a robust maintenance program. Descriptions of these design features are included in Section 4.2, AFacility Description,@ and Section 4.3, AProcess Description.@

Besides design features, the TWRS-P Facility maintenance program uses appropriate maintenance and inspection frequencies, procedures, training, and operational practices to ensure that exposure to maintenance and operational personnel is maintained as low as reasonably possible.

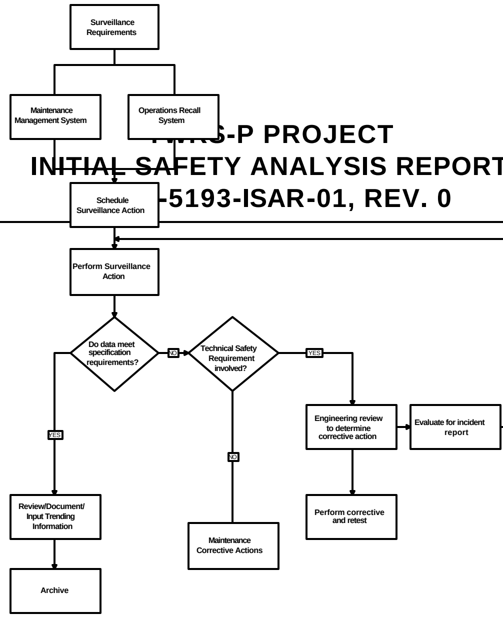
The TSR surveillance requirements identified in Section 4.8, AControls for Prevention and Mitigation of Accidents,@ are tracked by and implemented through the TWRS-P Facility maintenance management system (MMS), (see Section 3.2.4). Each TSR surveillance (test, calibration, or monitoring of facility equipment) demonstrates operability. Surveillance activities are performed in accordance with written procedures prepared by the facility engineering staff. The facility engineering staff is also responsible for surveillance results trending. Training of maintenance personnel, including personnel performing in-service surveillance calibration and testing, is discussed in Section 3.4 ATraining and Qualification.@ Operators performing surveillance testing or monitoring are trained according to the operator training and qualification plan described in Section 3.4. Figure 3-1 illustrates the major steps in the surveillance testing process.

As discussed in this section, maintenance is defined to include those functions performed primarily by mechanical, electrical, and instrument and control personnel. Maintenance includes servicing, overhaul, repair and replacement of parts, functional testing, calibration, inspection and monitoring, and the testing, calibration, and monitoring performed by personnel to comply with the TSR and LCR surveillance requirements. In addition, certain activities performed by personnel during the modification of SSCs are performed under maintenance program administrative controls, which supplement the configuration management controls described in Section 3.1, AConfiguration Management.@

3.2.1 Maintenance Organization and Administration{tc \l3 "3.2.1 Maintenance Organization and Administration}

Experience has shown that having well-defined, effectively administered policies and programs to govern maintenance activities results in the optimization of facility operations. At the TWRS-P Facility, written policies provide direction for effective implementation and control of maintenance activities that include assigning responsibilities and authority, controlling interfaces with other facility organizations, and addressing daily functioning of the maintenance organization. Facility management ensures that maintenance personnel work in close coordination with such organizations as operations, radiological protection, QA, fire protection, and industrial safety, as well as the various maintenance sections.

Written maintenance performance criteria and a trending process are used to monitor the effectiveness of the maintenance organization and program and the performance of Design Class I and II SSCs. Problems and incidents are analyzed and trended to identify important deficiencies or trends adverse to safety, such as equipment or material problems, procedure or training deficiencies, or personnel errors. Lessons learned from deficiencies are communicated to waste process industry sources and conversely, information from lessons learned at BNFL


Surveillance Requirements
Maintenance Management System
Operations Recall System
Schedule Surveillance Action
Perform Surveillance Action
Do data meet specification requirements?
NO
Technical Safety Requirement involved?
YES
Engineering review to determine corrective action
Evaluate for incident report
YES
NO
Review/Document/ Input Trending Information
Maintenance Corrective Actions
Perform corrective and retest
Archive

facilities and other industry sites are evaluated for applicability to the TWRS-P Facility. (Refer to Section 3.7, AIncident Investigations,@ for further detail.) Maintenance supervisors routinely monitor work in progress to ensure that maintenance activities are conducted in accordance with facility policies and procedures. Supervisors stress industrial safety and radiological protection practices; the quality of workmanship, material, and parts; and the effective use of procedures. *(The FSAR will provide a detailed description of the maintenance organization, roles, and responsibilities.)*

3.2.2 Types of Maintenance{tc \l3 "3.2.2 Types of Maintenance}

At the TWRS-P Facility, surveillance testing and routine, preventive, and corrective maintenance practices ensure that equipment degradation is identified and corrected, equipment life is optimized, radiological exposure to maintenance personnel is minimized, and the maintenance program is cost effective. A brief description of the categories of maintenance implemented at the TWRS-P Facility follows.

1) Surveillances Testing - Encompasses all the facility items subject to routine monitoring or testing under the auspices of the Operating License, the TSRs, *Code of Federal Regulations* (CFR) 29 CFR 1910, and 40 CFR 68, or the LCRs.

2) Routine Maintenance - Includes scheduled maintenance and overhaul tasks performed during facility operations to maintain or increase the reliability of the facility. Routine maintenance tasks are typically based on manufacturer recommendations, past experience with equipment, or vulnerability of components to the effect of aging. Routine maintenance also includes testing and calibrating instrumentation that is not subject to surveillance testing requirements.

3) Preventive Maintenance - Pertains to tasks scheduled to preclude potential degradation or failure in performance. This maintenance is typically based on information obtained from periodic testing such as surveillance testing or routine equipment monitoring. The results from predictive activities such as periodic functional testing, analysis of lubricants, and measurement of vibration and acceleration readings are used to predict failures and to schedule maintenance prior to these failures. Preventive maintenance also includes the scheduled maintenance activities performed during facility outages.

4) Corrective Maintenance - Includes those tasks required to repair or replace failed equipment.

Modifications may be necessary to rectify component failures discovered during maintenance, repair components following failures in operation, reduce the frequency of faults, improve maintainability, or incorporate a nonidentical replacement item. Facility modification work, including temporary modifications, is accomplished under the same basic administrative controls as those applied to facility maintenance activities and maintain the configuration management controls described in Section 3.1, AConfiguration Management.@

3.2.3 Maintenance Planning and Scheduling{tc \l3 "3.2.3 Maintenance Planning and Scheduling}

Maintenance management is responsible for establishing an effective system for planning, scheduling, and coordinating maintenance activities to ensure the following:

1) Operational limits, conditions, and applicable regulatory requirements are identified and understood by involved maintenance and operations staff members before maintenance is initiated or when Design Class I or II SSCs are to be removed from service.

2) Maintenance is accomplished in a coordinated and timely manner, using approved procedures.

3) Radiation exposure is kept as low as reasonably achievable.

4) Maintenance is efficient.

The coordination of maintenance work with other tasks is required to minimize any potentially adverse impact that the maintenance activity can have on facility operation and to ensure that the needed support (e.g., clearance tagouts, radiation work permits, and quality control inspection plans) is available. Planning activities are performed by maintenance supervision with input and review or approval provided by facility engineering, craft personnel, radiological protection personnel, operations personnel, and quality control specialists, as applicable. Scheduling and coordination of maintenance activities requires input from these organizations as well.

Maintenance work planning ensures that support items such as work instructions, special tools, qualified personnel, and repair parts and materials required to accomplish the work are available when needed. Planning reduces delays, helps ensure efficiency, and contributes to the maintenance of the facility condition, which, in turn results in a high level of availability.

Maintenance activity planning is implemented through a computer-based, integrated MMS similar to the system used at the BNFL Sellafield Site. The key aspects of MMS are described as follows.

1) Examination, inspection, maintenance, calibration, and testing activities are initiated by a task identification and description document (job card) generated by MMS.

2) Detailed maintenance results and equipment history information are maintained by MMS.

3) Job cards for planned maintenance activities describe or reference necessary key instructions, including procedures for removing and returning equipment to service.

4) The capability to analyze the recorded data and refine inspection and maintenance frequencies to ensure the most effective maintenance regime is available.

5) The capability to identify incipient or recurring equipment problems is available.

6) The capability to identify each Design Class I and II SSC and its associated regulatory testing, calibration, and maintenance requirements, frequencies, acceptance values, and current status is available.

For frequently repeated and simpler maintenance activities, the necessary work planning and controls are included on the MMS-generated job card. For larger scope maintenance activities, work control and planning are implemented by supplementing the job card with a more detailed work package. The work package preparation process addresses the following aspects of the job and is described in procedures (*to be written during Part B*):

1) Definition of the problem and identification of the work scope (including the need for safety assessments and an authorization basis review)

2) Identification of necessary procedures, drawings, vendor manuals, and maintenance history

3) Procurement of necessary repair parts, materials, tools, and equipment, and controls to ensure the integrity of the part up to the time it is installed

4) Assessment of staffing and skill requirements for facility, nonfacility, and subcontractor personnel

5) Prejob radiological protection planning for workers and the environment

6) Identification of initial conditions and prerequisites, including applicable TSRs and directions for removing and returning equipment to service, including safety tagouts

7) Identification of quality control inspection and code requirements

8) Establishment of equipment restoration and post-maintenance inspection or testing requirements

9) Identification of required pre-maintenance and post-maintenance communications with operations and other involved internal organizations.

Following completion of the task, the work-planning process requires appropriate reviews of completed work packages and job cards to ensure proper documentation, adequate post-maintenance testing, and entry of maintenance results into MMS. Reviews of defects found or adjustments made and the identified cause of the defect or adjustment are particularly important. The results of surveillance testing are reviewed for completeness, accuracy, and compliance to regulatory requirements. Operations supervision compares the work accomplished to the post-maintenance testing or inspections results, and determines that all work is acceptable prior to returning the equipment or system to normal service.

(The FSAR will provide a detailed description of the administrative controls to be applied to the maintenance planning process.)

3.2.4 Maintenance Procedures{tc \l3 "3.2.4 Maintenance Procedures}

The Maintenance Program is implemented by procedures or MMS job cards that provide the appropriate work direction to ensure that maintenance and surveillance activities are performed safely and efficiently. A balanced combination of written guidance, craft skills, and worksite supervision are used to achieve quality workmanship during maintenance operations. However, detailed maintenance or surveillance procedures are provided and used in all work that could result in 1) a significant process transient, 2) degraded facility reliability; or 3) a personnel or equipment hazard. Work directions are technically accurate, complete, up-to-date, and presented in a clear, concise, and consistent manner to minimize human error.

Maintenance procedures used for significant evolutions are subject to verification and validation. Verification is a review to ensure the proper format and technical accuracy of a new or revised procedure. This review also ensures that the format incorporates human factors principles and other appropriate administrative policies. The validation process ensures that the procedure provides sufficient and understandable guidance and direction and that the procedure is compatible with the equipment or system being maintained. Validation is typically performed in the field prior to initial procedure use.

Procedure compliance requirements are clearly stated in the procedure or provided as general administrative guidance, addressed in the maintenance training program, and thoroughly understood by facility personnel.

3.2.5 Post-Maintenance Testing{tc \l3 "3.2.5 Post-Maintenance Testing}

Post-maintenance testing commensurate with the maintenance work performed and the importance of the equipment to safety and reliability is conducted to ensure that components fulfill their design function when returned to service. Control and documentation of post-maintenance testing are addressed in administrative procedures and are part of the MMS process.

Post-maintenance testing instructions address applicable codes, TSRs, and any additional applicable testing requirements, and the instructions describe acceptance criteria, data recording, and special documentation requirements. The operations organization is responsible for coordinating test performance and ensures that equipment is declared operable only when post-maintenance testing has been completed satisfactorily.

3.2.6 Maintenance Training and Qualification{tc \l3 "3.2.6 Maintenance Training and Qualification}

A Maintenance Training and Qualification Program develops and maintains the skills and knowledge needed by maintenance personnel to effectively perform maintenance and surveillance activities. This program is described in Section 3.4, ATraining and Qualification.@ Maintenance employee qualification requirements include a combination of education, experience, and job- and task-specific training. Maintenance management is responsible for proper training of maintenance personnel and for evaluating and the continuing improvement of the training program for their staff. Specific training provided to maintenance personnel addresses employee orientation and emergency procedures, health and safety, occupational radiation protection, environmental protection, specific craft skills associated with assigned tasks, and Design Class I and II systems training. The Design Class I and II systems training covers system function, construction, operations, and supporting services. Training stresses the importance to safety of maintenance tasks and the potential safety consequences of technical or procedural errors. Stop work is included in the training of maintenance personnel as a viable method to assure safety.

3.2.7 Maintenance Facilities and Equipment{tc \l3 "3.2.7 Maintenance Facilities and Equipment}

The TWRS-P Facility maintenance and maintenance training organizations are provided with sufficient equipment, tools, and maintenance facilities to effectively support a strong maintenance program. To limit and control the movement of contaminated equipment and the spread of radioactive effluent resulting from decontamination, maintenance operations on contaminated equipment are performed within the confines of the TWRS-P Facility process building. The process building contains a remotely operated maintenance facility designed for specified maintenance activities, as well as maintenance and breakdown cells and a general purpose controlled workshop. The BNFL Inc. designs that support these facilities and their associated equipment are existing and proven. The layout of all shops and work areas are designed with a high priority on worker safety and human factor considerations.

Storage facilities for supplies and parts are important considerations in providing safe, efficient, and high-quality maintenance. Storage facility design addresses isolation or segregation of chemicals, flammability of lubricants and paint, qualification of parts and components, damage to components and supplies resulting from environmental effects, and control of radioactive materials. Inventory levels of spare parts, supplies, and equipment are maintained to support safe and reliable facility operation. Employees responsible for the selection and storage of supplies and parts are trained to understand and implement the administrative controls established for these activities. This training also addresses the technical basis for storage facility controls.

3.2.8 Management Involvement with Facility Operations{tc \l3 "3.2.8 Management Involvement with Facility Operations}

BNFL Inc. corporate and facility management maintain sufficient involvement with facility safety, the facility license, and facility operations to be technically informed and personally familiar with conditions at the TWRS-P Facility. This involvement includes periodic review of the maintenance program to verify that it is effectively accomplishing the intended objectives and is upgraded as needed.

To facilitate effective review of the maintenance program, management establishes and tracks performance indicators, goals and objectives, and problem identification and corrective action processes. Management reviews also assess the effectiveness of the maintenance training and the control of parts and supplies.

3.3 QUALITY ASSURANCE{tc \l2 "3.3 QUALITY ASSURANCE}

The TWRS-P Project Quality Assurance Program (QAP) ensures that the design, procurement, construction, testing, inspection, operation, maintenance, and deactivation activities conform to safety requirements. The QAP describes the organizational structure, functional responsibilities, levels of authority, and interfaces for those managing, performing, and assessing the work performed. This section describes the essential features of the QA program and the actions that demonstrate and ensure that the TWRS-P Project meets the requirements of 10 CFR 830.120, AQuality assurance requirements,@ as presented in BNFL-5193- QAP-01, *Tank Waste Remediation System Privatization Project Quality Assurance Program* (BNFL 1997a).

For Part B activities, the QAP will reflect the applicable requirements of 10 CFR 830.120, the Office of Civilian Radioactive Waste Management (OCRWM), DOE/RW-0333P, *Quality Assurance Requirements and Description (QARD)* (DOE 1995), for immobilized high-level waste, and NUREG-1293, *Quality Assurance Guidance For a Low-Level Radiological Waste Disposal Facility* (NRC 1989b), for immobilized low-activity waste, as well as other consensus standards such as ASME-NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, (ASME-NQA-1).

Adherence to the TWRS-P Project QAP ensures the following:

1) Missions and objectives are accomplished

2) Products and services are safe, reliable, and meet the requirements of the TWRS-P Facility regulator

3) Hazards to the workers, public, and environment are minimized.

3.3.1 Management Commitment for the Quality Assurance Program{tc \l3 "3.3.1 Management Commitment for the Quality Assurance Program}

The TWRS-P Project has developed a Project Quality Policy that indicates the level of commitment given to establishing and implementing an effective QA program. This policy statement is contained in BNFL-5193-QAP-01 (BNFL 1997a), and is presented below:

> "This Quality Assurance Program (QAP) is developed to conform with the Quality Assurance (QA) principles stipulated by DOE in the document, Top-Level Radiological, Nuclear, and Process Safety-Standards and Principles for Tank Waste Remediation System (TWRS) Privatization Contractors, DOE/RL-96-0006, Revision 0. These principles are related to the following:
>
> 1) Safety/Quality Culture
> 2) Quality Assurance Application
> 3) Configuration Management
> 4) Design
> 5) Proven Engineering Practices.
>
> BNFL Inc. is committed to establishing and implementing a QAP that meets all requirements of Title 10, Code of Federal Regulation (CFR), Part 830.120, as identified in RL/REG-96-01, Revision 0 "Guidance for Review of TWRS Privatization Contractor Initial Quality Assurance Program," without exceptions.
>
> The provisions of this Tank Waste Remediation System Privatization (TWRS-P) Project QAP apply to all BNFL Inc. activities that may affect radiological, nuclear, or process safety within the scope of work for Part A of the contract.
>
> The TWRS-P Project QAP is endorsed by BNFL Inc. Corporate QA Management and approved by the Project Manager for the TWRS-P Project."

3.3.2 Scope of the Quality Assurance Program{tc \l3 "3.3.2 Scope of the Quality Assurance Program}

The TWRS-P Project QAP establishes a planned and systematic set of actions necessary to provide adequate confidence that Part A activities are satisfactorily conducted to meet radiological, nuclear, and chemical safety requirements. The TWRS-P Project organization will transition through phases that will ultimately result in the safe removal of hazardous radioactive wastes from the Hanford Site tanks for processing. The three distinct parts include the following:

1) Part A - the conceptual phase during which the technical, regulatory, financial, and commercial aspects are developed

2) Part B1 - the detail design, permitting, and construction phase

3) Part B2 - the cold test, hot startup, operational, and deactivation phase of the Phase I TWRS-P demonstration project.

The BNFL-5193-QAP-01 (BNFL 1997a) will be revised to reflect changes necessary to support Part B activities. Changes made to the QAP over the previous year are submitted annually to the TWRS-P Project regulator for review in accordance with 10 CFR 830.120(b)(4). Changes are identified, the reasons for the changes are provided, and the basis for concluding that the revised QAP continues to satisfy the requirements are included. BNFL Inc. retains primary responsibility and accountability for the scope and implementation of the QAP.

Each principal subcontractor is also required to establish and implement its own QAP for the TWRS-P Project under the overall direction of BNFL Inc. project management. The principal subcontractors= QAPs will meet the applicable criteria of 10 CFR 830.120 for their scope of work. BNFL Inc. reviews and approves the QAPs developed by the principal subcontractors. In addition, BNFL Inc. conducts audits and assessments to verify the principal subcontractors= compliance with QAP requirements.

3.3.3 Organizational Responsibility{tc \l3 "3.3.3 Organizational Responsibility}

BNFL Inc., as the prime TWRS-P Facility contractor, has assembled a design and construction organizational team to provide management and technical support to the tasks of the project. This team ensures that responsibilities, resources, technical expertise, and management involvement are properly integrated for safe, effective, and efficient completion of the TWRS-P Facility. The TWRS-P Project management accomplish this mission in a manner that protects the health and safety of the public and workers and protects the environment from degradation.

Responsibilities and authorities of TWRS-P Project staff for Part A activities are presented in BNFL-5193-QAP-01 (BNFL 1997a) and in Chapter 2.0, AManagement Organization.@

3.3.4 Quality Assurance Program Description{tc \l3 "3.3.4 Quality Assurance Program Description}

This section summarizes how TWRS-P Project management implements the quality requirements of 10 CFR 830.120, and how the responsibility of the scope and implementation of the quality program will be assigned to project management and management of organizations supporting the TWRS-P Project. At all levels, TWRS-P Project management is responsible for planning, implementing, and assessing programs for design, construction, operations, and deactivation of the TWRS-P Facility.

Compliance with the TWRS-P Project QAP is achieved by implementing written procedures, instructions, and drawings. Procedures, instructions, and drawings include the appropriate quantitative or qualitative acceptance criteria for determining that activities affecting quality have been satisfactorily accomplished. Control over quality-affecting SSCs, processes and services is assigned to an extent commensurate with their importance to safety, and as necessary to ensure conformance to the approved BNFL Inc. QAP. Application of this graded approach is described in Section 3.3.5, AGraded Quality Assurance Approach,@ and Section 3.3.6, AApplication of Graded Quality Assurance to SSCs, Processes, and Activities.@

The TWRS-P Project QA organization reviews and documents concurrence of quality affecting procedures. The QA organization reviews the quality-affecting procedural controls of BNFL Inc. prime subcontractors and must document its agreement before the initiation of safety-related activities. The content, control, and the review and approval process for procedures are described in project procedures. Should a difference of opinion arise between organizations regarding the quality of safety-related activities, project procedures to provide a process for the resolution of the dispute.

The TWRS-P Project QA Manager and designated QA personnel (who are sufficiently free from direct pressures resulting from operational concerns) have the authority and the responsibility, as delineated in writing, to stop work in unsafe situations and to control further operation until the conditions that created the unsafe conditions are corrected.

The TWRS-P Project requires that Quality Level 1 (QL-1) and QL-2 suppliers providing equipment, processes, and services develop a QAP compatible with the requirements of 10 CFR 830.120 and specific to the scope of the suppliers work process. The QAPs of suppliers are submitted to the TWRS-P Project QA organization for review and approval. The process for review and approval of suppliers of equipment, processes, and services is accomplished in accordance with approved procedures.

The authority, responsibilities, lines of communication, and duties of persons and organizations performing quality-affecting activities are provided in Chapter 2.0, AManagement Organization.@ The implementation of these roles is described in approved procedures.

3.3.4.1 Personnel Training and Qualification{tc \l4 "3.3.4.1 Personnel Training and Qualification}. TWRS-P Project personnel performing activities affecting quality are trained and qualified to perform assigned tasks. The training and qualification program provides the development of personnel proficiency commensurate with the scope, complexity, safety impact, and other factors of an assigned activity. This proficiency includes knowledge of the work processes, tools, equipment, and requirements including purpose, scope, and implementation of quality-affecting manuals, procedures, and instructions.

Management is responsible for developing generic staff position requirements based on the level of education and experience necessary for proficient performance of tasks related to a given staff position. Qualification and training requirements for specific positions are based on a documented analysis of the specific duties and tasks associated with those positions. The training, in addition to the knowledge of the correct processes and methods to accomplish an assigned task, covers the fundamentals applicable to the work, the physical or operational conditions within which the work is performed, and the TWRS-P Project policy relevant to special requirements that may be associated with the task.

TWRS-P Project management is responsible for ensuring that their staff is sufficiently trained to perform assigned tasks in a manner that minimizes 1) risk to the worker performing the task, and the public, 2) negative impacts to the environment, and 3) risk of damage to the facility and facility equipment. Training includes on-the-job training (OJT), formal training sessions, reading assignments, refresher courses, technical seminars and conferences, and self-study. Indoctrination and training activities are completed before performing the assigned work.

Proficiency tests are given to those personnel performing and verifying activities affecting quality. Acceptance criteria that demonstrate the proper training and qualification of the staff are established.

Continuing training (i.e., retraining or reexamining, as required) to ensure that job proficiency is maintained for personnel performing and verifying activities affecting quality is also established. Qualification and training requirements are reviewed periodically (at least annually) to ensure that requirements continue to reflect the current systems, procedures, and policies applicable to each position, as required. More frequent reviews are scheduled, if considered necessary, commensurate with the scope of work and status of the project.

The implementation of the training and qualification requirements of the QAP for activities such as maintaining trainer standards, identification of specific training requirements, and maintenance of training records is incorporated into the overall project training program. Training is provided by instructors having the technical and instructional skills necessary to provide the training in an effective manner. Management evaluates training program efficacy and efficiency through interviews, feedback from instructors, students, students' managers, and periodic reviews. Corrective actions or necessary improvements identified during the evaluations are implemented and tracked to completion.

Section 3.4, ATraining and Qualification,@ provides additional detail on the TWRS-P Project personnel training and qualification program. Training and qualification records for individuals performing quality-affecting activities are managed under the records management program described in Section 3.8, ARecords Management.@

3.3.4.2 Quality Improvement{tc \l4 "3.3.4.2 Quality Improvement}. The objective of the TWRS-P Project quality improvement program is to detect and prevent problems adversely affecting quality, and to strive to continuously improve the quality of SSCs, processes, and services. The bases of the approach to quality improvement are that: 1) work activities can be planned, performed, assessed, and improved; and 2) lessons learned from this process can be used to improve subsequent activities. Quality improvements are achieved through implementation of the following:

1) Project reviews

2) Analysis of data for trends
3) Employee recommendations
4) Lessons learned and industry experience
5) Surveillances
6) Technical oversight
7) Management assessments and independent assessments and audits
8) Corrective action process.

Under the corrective action program, organizations have the responsibility to identify quality problems and to initiate, recommend, or provide solutions through designated channels. Various management systems (e.g., root cause analysis and lessons learned) are used to plan, evaluate, and implement improvements. The TWRS-P Project personnel are encouraged to identify potential areas for improvement.

The SSCs, processes, and services that do not meet established quality requirements are controlled and corrected as soon as practical commensurate with a graded approach. The corrective action process includes identifying the root cause(s) of the problem, determining corrective action(s) for the causes, and initiating additional corrective action(s) necessary to preclude recurrence. Guidance and criteria used to determine the significance of the problem are provided so that actions can be taken appropriate to the importance of the nonconformance. Significant conditions adverse to quality, root cause of the condition, and corrective actions taken to preclude recurrence are documented and reported to immediate and upper levels of management. The TWRS-P Project regulator is notified of significant nonconforming conditions identified at the facility.

Documentation of nonconforming items or activities includes the following information: identification and description of the nonconformance, actions for resolution or disposition of the nonconformance (e.g., the inspection or testing requirements), and management approval of the recommended actions. Additional details on the process for reporting potential areas for improvement and resolving quality problems are also contained in procedures. The QA organization provides concurrence on the adequacy of the corrective action(s), verifies implementation of the corrective action(s), and closes out the corrective action in a timely manner, in accordance with approved procedures.

(QA and other organizational responsibilities will be provided in the PSAR for the definition and implementation of activities related to nonconformance control. This includes identifying those individuals or organizations with authority for the disposition of nonconforming items.)

Nonconforming items that are reworked, repaired, or replaced are reviewed, accepted, and then tested in accordance with original equipment inspection and testing requirements or acceptable alternatives. Controls placed on nonconforming items prevent inadvertent installation or use through identification, documentation, evaluation, segregation (when applicable), and disposition of the nonconforming item.

TWRS-P Project organizations affected by the nonconforming items or activities are notified. The SSCs, processes, and services that do not conform to specified requirements are controlled so the SSC, process, or service is not inadvertently used. The processes for identifying nonconformance, notifying affected organizations of nonconformance, accepting nonconforming items, and controlling nonconformance (by lock and tag, work control, and other applicable controls) are described in the approved procedures.

Performance indicators, item characteristics, process implementation, corrective actions, assessments, and other quality-related information are reviewed and the data are analyzed to identify SSCs, processes, and services needing improvement. Quality improvements are implemented using a graded approach in accordance with management direction. Criteria include consequences of failure, complexity or uniqueness, special control requirements, testability, quality history, and other factors, as described in Section 3.3.5, AGraded Quality Assurance Approach,@ to enhance SSCs, processes and services improvements. The process for establishing performance indicators, trending, reporting results, developing corrective actions, and tracking completion is described in procedures.

In addition, the QA organization periodically analyzes management assessments, independent audits and assessments, and nonconformance and incident reports to determine quality trends. Significant results are reported to management for review, evaluation, and initiation of appropriate actions.

3.3.4.3 Documents and Records{tc \l4 "3.3.4.3 Documents and Records}. The TWRS-P Project documents and records system establishes requirements for control of the preparation, review, approval, issuance, use, and change to documents that prescribe processes, specify requirements, or establish design to ensure that correct documents are being employed. These documents include design documents (e.g., calculations, drawings, specifications, and analyses) and other documents relating to computer codes; procurement documents; instructions and procedures for activities such as fabrication, construction, modification, installation, maintenance, testing, and inspection; as-built conditions; QA and quality control manuals and quality-affecting procedures; and technical reports.

These controlled documents and their revisions are reviewed for technical adequacy, inclusion of appropriate safety and quality requirements, completeness, and correctness before approval and implementation. The controlled documents contain appropriate quantitative or qualitative acceptance criteria (e.g., those documents pertaining to dimensions, tolerances, and operating limits) to determine that activities affecting quality have been satisfactorily accomplished. The QA organization reviews and concurs with these documents with respect to QA-related aspects. Changes to documents are reviewed and approved by the same organization as those that performed the initial review and approval or by another qualified organization as delegated by the TWRS-P Project management.

Design basis and other requirements necessary to ensure adequate quality are referenced in documents used to procure items or services. Suppliers are required to implement a QAP consistent with the quality level of the items or services being procured (see Section 3.3.5, AGraded QA Approach@).

Following approval, controlled documents are released for use at the work location for the prescribed activity to be performed. Obsolete or superseded documents are removed and replaced by applicable revisions in a timely manner. The document control system identifies the current revision of instructions, procedures, specifications, drawings, and procurement documents that are distributed to applicable personnel. Details of the TWRS-P Project document control system are contained in procedures or instructions for 1) procedure manual control, 2) technical procedure development, modification, and 3) administration; and compliance.

(Organizational responsibilities to ensure that activities affecting the quality of safety-related activities are prescribed by documented instructions, procedures, and drawings and are accomplished through implementation of these documents will be described in the PSAR.)

The definition of records and the requirements for the records management activities are discussed in Section 3.8, ARecords Management.@

(QA and other organizations involved in the definition and implementation of QA records and activities affecting quality and the protection of the environment will be identified and their responsibilities will be defined in of the PSAR).

3.3.4.4 Work Processes{tc \l4 "3.3.4.4 Work Processes}. TWRS-P Project work processes include, but are not limited to, quality-affecting activities involving designing, fabricating, procuring, constructing, handling, shipping, storing, cleaning, assembling, inspecting, installing and testing, operations, making modifications, performing maintenance and repair deactivating items. Details of the work control process from initiation of a work request through post-review to ensure personnel safety, equipment protection, and facility configuration (including content and controls for a work package) are established.

The TWRS-P Project management is responsible for ensuring the preparation, control, and implementation of written policies, procedures, and instructions which control the performance of work. When specified, TWRS-P Project management is also responsible for maintaining objective evidence of work completion. Work on the TWRS-P Facility is planned, authorized, and performed under controlled conditions in accordance with approved technical standards and administrative controls using approved procedures, instructions, and plans commensurate with a graded approach. Such procedures, instructions, and plans contain, or reference, the necessary administrative and technical requirements including the sequence of actions and interactions required to ensure that activities are properly performed and meet acceptance criteria. Work process documents are readily accessible to the worker.

This work process documentation is reviewed to ensure that the desired quality is maintained and to identify areas for improvement. This ensures that process parameters are controlled within defined limits and that specified environmental conditions are maintained.

Special processes (e.g., welding, heat treating, nondestructive testing, and chemical cleaning) are performed by qualified personnel, with the required equipment, in accordance with specified requirements including applicable codes, standards, specifications, criteria and other special requirements as directed by approved procedures or instructions. *(Organizational responsibilities, including those of the QA organization, will be described for the safety qualification of special processes, equipment, and personnel in the PSAR.)*

Handling, marking, storing, packaging, shipping, cleaning, and preserving materials and other items are controlled to prevent damage, loss, or deterioration from environmental conditions such as temperature or moisture. Identification of items is maintained throughout packaging, shipping, handling, and storage. Special protective measures are specified and provided when required to maintain acceptable quality (e.g., an inert gas atmosphere, specific moisture content, and temperature levels). Special cleaning, handling, preserving, storing, packaging and shipping requirements are established and implemented by trained staff in accordance with predetermined work and inspection instructions.

Materials and parts important to the function of quality-affecting SSCs are controlled for tracing to the appropriate documentation such as drawings, specifications, purchase orders, manufacturing and inspection documents, deviation reports, and physical and chemical test reports. Controls ensure that only correct and accepted materials, parts, and components are being used and that these materials, parts, and components are verified and documented before they are released for fabrication, assembling, shipping, or installation. Controls for such materials and parts are described in procedures or instructions applicable to the process.

Provisions are required for identifying, controlling, calibrating, and periodically adjusting equipment (e.g., tools, gauges, instruments, and other measuring and testing devices) used for process monitoring and data collection. These controls are described in procedures or instructions applicable to the process.

See Sections 2.1, AOrganization and Administration;@ 3.1, AConfiguration Management;@ 3.2, AMaintenance;@ and Section 3.8, ARecords Management,@ for additional detail on the TWRS-P Project work process.

3.3.4.5 Design{tc \l4 "3.3.4.5 Design}. Sound engineering and scientific principles, Safety Requirements Document (SRD) Safety Criteria, codes, standards, and practices for ensuring technical quality are identified and incorporated into the TWRS-P Facility design of new or replacement items to meet system design requirements. Basic areas affecting design include design inputs, design process and interfaces, design verification, design changes, and documentation requirements. The overall process of design control and control of engineering procedures is performed in accordance with approved procedures and instructions.

3.3.4.5.1 Design Input{tc \l5 "3.3.4.5.1 Design Input}. Design inputs consist of applicable design requirements based on the SRD safety criteria, design basis, performance requirements, Federal regulations, contract specifications, environmental conditions, and interfaces with the facility configuration.

3.3.4.5.2 Design Process{tc \l5 "3.3.4.5.2 Design Process}. Appropriate quality standards are identified and documented and their selection is reviewed and approved by (*position title later*). Design methods, materials, parts, equipment, and processes that are essential to the functions of the items affecting quality are selected and independently reviewed for suitability of application. Deviations from quality standards are identified and controlled in accordance with procedures or instructions.

Design analyses are performed and documented by the TWRS-P Project in a planned and controlled manner. Calculations are identifiable by subject (including items to which the calculations apply); originator, reviewer, and date; or by other data such that the calculations are retrievable.

The final design of the TWRS-P Facility is relatable to the design basis input by documentation in sufficient detail to permit design verification and by identification of assemblies or components that are part of the item being designed. Design documents are adequate to support facility design evolution, construction, operation, and deactivation. The documentation references include SRD safety criteria and applicable codes, standards, and practices, as well as applicable regulatory safety requirements.

Control of engineering drawings and sketches are provided in procedures that also contain details for incorporating design inputs into new or modified designs. Other facets of the design documentation process are proceduralized to support facility design, construction, startup, operation, and to ensure incorporation of the applicable codes, standards, and practices.

Some specifications require suppliers or contractors to design certain components. The supplier's or contractor's designs are reviewed and approved for technical adequacy and to maintain control of procurement and installation specifications. Other facets of the design analyses process performed by others (including quality standards, deviations to quality standards, and design) are controlled by written instructions.

Design documents that pertain to facility safety and are subject to procedural control include, but are not limited to, specifications, calculations, system descriptions, and drawings, including flow diagrams, piping and instrument diagrams, control logic diagrams, and electrical one-line diagrams. Specialized reviews are used when uniqueness or special design considerations warrant them.

(Organizational responsibilities for preparing, reviewing, approving, and verifying design documents related to safety features of the facility or its processes, such as system descriptions, design input and criteria, design drawings, design analyses, computer programs, specifications, and procedures will be described in the PSAR.)

Whenever possible, new and revised designs use materials, components, and processes already in use and proven in similar applications. Applicable data and documentation are used whenever necessary to validate changes requested and to establish requirements for any design verification necessary for validation.

3.3.4.5.3 Design Interfaces{tc \l5 "3.3.4.5.3 Design Interfaces}. TWRS-P Project design interfaces are identified and controlled, and design efforts are coordinated among the participating organizations. Interface controls are documented and include the assignment of roles and responsibility and the establishment of procedures among participating design organizations for the review, approval, release, distribution, and revision of documents involving design interfaces. Design information documentation transmitted across organizational interfaces is controlled. Transmittals identify the status of the design information or documents provided and where necessary, identify incomplete items that require further evaluation, review, or approval. Design interfaces among the various TWRS-P Facility organizations are described in approved procedures or instructions.

3.3.4.5.4 Design Verification{tc \l5 "3.3.4.5.4 Design Verification}. Verification of the adequacy of design products is performed for, but not limited to, key design documents (e.g., design analyses, engineering studies, technical reports, system descriptions, flow diagrams, piping and instrument diagrams, control logic diagrams, electrical one-line diagrams, structural systems for major facilities, site arrangement, and equipment location drawings). Specifications and calculations prepared in support of the key design documents are also verified. Documentation of the design verification is provided by a design verification report signed by the (*position title later*).

Design drawings and specifications for SSCs affecting quality are reviewed by the QA organization to ensure that the documents are prepared, reviewed, and approved in accordance with TWRS-P Project procedures and that the documents contain necessary QA requirements (e.g., inspection and test requirements, acceptance requirements, and documentation requirements for inspection and test results).

Design adequacy is verified in accordance with approved procedures by the following: individual or interdisciplinary design reviews; alternate calculations to verify the correctness of the original design calculations; or qualification testing. Verification by qualification testing is permitted if the following are true:

1) Procedures provide criteria that specify when verification should be by test.

2) Prototype, component, or feature testing is performed as early as possible before installation of facility equipment or before the installation would become irreversible (e.g., require extensive demolition and rework).

3) The test is performed under conditions that simulate the most adverse design conditions as determined by analysis.

Design verifications are performed in a timely manner to identify, document, and correct design errors prior to approval and implementation of the design. Design verification for the level of design activity accomplished is performed prior to release for procurement, manufacture, construction, or release to another organization for use in other design activities. The design verification may be deferred provided 1) that the justification for this action is documented, and 2) that the unverified portion of the design output documents, and all design output documents based on the unverified data are appropriately identified and controlled. The *(position title later*) has the authority to defer design verification.

The TWRS-P Project procedures specify the process for the independent safety review and approval of design packages, design changes and revisions, safety analyses, operational safety limits, and operational safety requirements. The independent safety reviews include the following objectives:

1) Determine that the design will perform the safety functions in the required operational modes (i.e., normal, off-normal, and accident conditions)

2) Determine that the design satisfies the SRD safety criteria; meets applicable codes, standards, design criteria; and meets requirements that could have an impact on safety

3) Determine that the design is compatible with the Hazards Analysis Report (HAR), Integrated Safety Analysis (ISA), and human factors principles and processes

4) Determine that the appropriate safety classification is assigned

5) Determine that the design incorporates required features to ensure protection of facility personnel, the public, and the environment.

Design safety reviews also focus on human factors. Reviews of human factors considerations include the following items:

1) When administrative controls are used to prevent or mitigate the effects of an accident, consider and clearly identify adequacy of the following: appropriate system monitoring and annunciation; post-accident habitability of control stations; appropriate operator response time; appropriate interlocks to prevent spurious or inadvertent operation; and provisions for remote operation.

2) Adequate human factors considerations are taken into account in the system design including layout and location of controls, readouts, and annunciators; information displays are consistent with accident analyses; and operating safety requirements or operating safety limits are specified in units, ranges, and types.

Design deficiencies resulting from this review are documented and corrective actions are determined by TWRS-P Facility line management. Implementation of the corrective actions is accomplished in a timely manner. Another safety review is conducted after the implementation of corrective actions to determine their effectiveness.

The adequacy of design products is verified by an individual or organization who have not performed the work but have the appropriate qualifications to effectively assess the work.

The originator's immediate supervisor may perform the design verification if the following items are true:

1) The supervisor is the only technically qualified individual.

2) The need is individually documented and approved in advance by the supervisor=s management.

3) QA audits and assessments address the frequency and effectiveness of the use of supervisors as design verifiers to guard against abuse.

Responsibilities of the verifier, the areas and features to be verified, the pertinent considerations to be verified, and the extent of documentation are described in procedures.

3.3.4.5.5 Computer Software{tc \l5 "3.3.4.5.5 Computer Software}. Computer programs used for design analysis of the TWRS-P Facility are verified and validated to show that they produce correct solutions for the encoded mathematical model within defined limits for each parameter employed and that the encoded mathematical model has been shown to produce a valid solution over the range of applications to the physical problem associated with the particular application. The extent of validation is based on the complexity, risk, and uniqueness of the design.

Computer programs are controlled to ensure that changes are documented and approved by appropriate personnel. Control requirements include development, acquisition, use, modification, error notification, and configuration management of software used in computer systems.

3.3.4.5.6 Design Changes{tc \l5 "3.3.4.5.6 Design Changes}. Design changes, including field changes, modification to operating facilities, and nonconforming items dispositioned as Ause-as-is@ or Arepair@ are subject to design control measures commensurate to those applied to the original design. These measures include assurance that the design analyses establishing the safety basis for the SSC are still valid. Verification and review of design changes are performed to the same level as that of the original design. Design changes are documented and verified as established in the configuration management process.

See Section 3.1, AConfiguration Management,@ for additional information concerning the TWRS-P Project design change process.

3.3.4.5.7 Design Documentation and Records{tc \l5 "3.3.4.5.7 Design Documentation and Records}. Design documentation and records, which provide evidence that the design and the verification process were accomplished in accordance with the requirements, are collected, maintained, and stored in accordance with Section 3.8, ARecords Management.@

3.3.4.6 Procurement{tc \l5 "3.3.4.6 Procurement}. Procurement documents (e.g., purchase orders, purchase requisitions, external work orders, and store orders) are controlled by implementing procedures to ensure that regulatory requirements, design, applicable quality requirements, design basis, and other requirements necessary to ensure adequate quality are included or referenced.

The procurement documents include the following:

1) Quality requirements that are inspectable and controllable

2) Applicable regulatory, technical, administrative, and reporting requirements

3) Drawings, specifications, codes and industrial standards, test and inspection requirements, and special process instructions

4) The names of TWRS-P Facility personnel responsible for implementing these requirements

5) Adequate acceptance criteria

6) The specification of the characteristics or processes to be witnessed, inspected or verified, and accepted

7) The method of surveillance and the extent of documentation required

8) Audits, surveillance, or inspections that ensure the supplier complies with the quality requirements

9) Requirements for identification, control, approval, and distribution of supplier-generated documents.

Controls ensure that purchased items and services conform to the procurement documents. These controls include provisions for source evaluation and selection, objective evidence of inspection at the contractor or subcontractor source, examination of items or services upon delivery, and assessments. Verification of suppliers= activities during fabrication, inspection, testing, and shipment of materials, equipment, and components are performed with QA organization participation to ensure conformance with the purchase order requirements.

Procurement of spare or replacement parts for quality-affecting SSCs are subject to QA program controls, codes and standards, and technical requirements equal to or better than the original technical requirements, or as required to prevent the procurement of defective parts. The process for the procurement of spare or replacement parts is proceduralized.

Records that an item furnished by a supplier conforms to code, regulation, or contract procurement requirements are completed before installation or implementation. Methods established for the acceptance of an item furnished by suppliers consist of one or more of the following:

1) Supplier certification and release (Certificate of Conformance)
2) Source verification or inspection
3) Receiving inspection
4) Acceptance testing
5) Post-installation testing.

Records of the acceptance of a service (e.g., third-party inspections, engineering and consulting services, analytical laboratory services, installation, repair, overhaul, or maintenance work) furnished by suppliers consist of one or more of the following:

1) Technical verification of data produced

2) Surveillance or assessment of the activity

3) Review of objective evidence for conformance to the procurement document requirements (e.g., certifications and stress reports).

Assessments are performed, evaluated, and documented to determine the effectiveness of the supplier=s control of quality before selection and periodically during supplier performance at intervals consistent with the importance, complexity, and quantity of the items or services. The evaluation and selection of procurement sources are based on specified criteria, including one or more of the following evaluations:

1) Evaluation of the supplier's quality history of providing an identical or similar product that performs satisfactorily in actual use

2) Review of the supplier's current QA records supported by documented qualitative and quantitative information that can be objectively evaluated

3) Direct evaluation of the supplier's facilities, personnel, and QA program implementation to determine the technical and quality capability of that supplier.

Assurance is obtained that approved suppliers can continue to provide acceptable items and services based on a documented evaluation of their past performance. Suppliers are either reevaluated and retained on the basis of continued satisfactory performance or removed from a list of acceptable suppliers.

The performance history evaluation includes the following:

1) Evaluation of the supplier's nonconformance report history relative to received items or services

2) Communications with the purchasing organization to determine if any contractual problems have been encountered

3) Communications with the supplier to determine if any changes to their QA program have occurred since their initial acceptance.

(The organizational responsibilities including interaction between design, procurement, and the QA organization will be provided in the PSAR. This will include organizational responsibilities for procurement planning.)

3.3.4.7 Inspection and Acceptance Testing{tc \l4 "3.3.4.7 Inspection and Acceptance Testing}. Inspections and acceptance testing of specified TWRS-P Facility items, services, and processes are performed in accordance with established acceptance and performance criteria. Inspection and acceptance criteria are derived from engineering design documents, supplier information, construction procedures, and maintenance procedures.

A qualification program for inspectors documents that the qualifications and certifications of inspectors are current. Individuals performing inspections are not selected from those who performed or directly supervised the activity being inspected or report directly to the immediate supervisors responsible for the activity being inspected. If the individuals performing inspections are not part of the QA organization, the inspection procedures, personnel qualification criteria, and independence from undue pressure, such as operational needs, are reviewed and found acceptable by the QA organization before initiation of the activity.

Suppliers and contractors inspect and test their own work. An independent audit, assessment, or surveillance of suppliers and contractors performed by the TWRS-P Project ensures that these inspections and tests are adequately and competently performed.

The material, components, or equipment are inspected on receipt to ensure the following:

1) The material, component, or equipment is properly identified and corresponds to the identification on the purchase document and the documentation when the item is received

2) Materials and parts important to the function of quality-affecting SSCs can be traced to the appropriate documentation (e.g., drawings, specifications, purchase orders, manufacturing and inspection documents, deviation reports, and physical and chemical test reports)

3) Specified inspection, test, and other records (e.g., certificates of conformance attesting that the material, components, and equipment conform to specified requirements) are available at the TWRS-P Facility before installation or use of the item.

Suppliers provide the following records to the TWRS-P Project, as required:

1) Documentation that identifies the purchased item or service and the specific procurement requirements (e.g., codes, standards, and specifications) met by the item or service

2) Documentation that identifies any procurement requirements that have not been met, including a description of those items that are designated Aaccept as-is@ or Arepair.@

The review and acceptance of these documents is described in the TWRS-P Project QAP. For commercial Aoff-the-shelf@ items where specific QA controls cannot be imposed in a practicable manner, special quality verification requirements are established and described to ensure that an acceptable item has been received by the TWRS-P Project. Suppliers certificates of conformance are periodically evaluated by audits, independent inspections, or tests to ensure that they are valid and that the results are documented.

The inspection and test process establishes the system by which the inspection and test status of items are controlled to ensure that items which have not passed the required inspections and tests are not inadvertently installed, used, or operated. Status of inspection and test activities are traceable throughout fabrication, installation, and use.

Controls identify items that have satisfactorily passed required inspections and tests where necessary to preclude inadvertent bypassing of the inspection and test. Controls also identify the operating status of SSCs of the TWRS-P Facility (e.g., tagging valves and switches to prevent inadvertent operation).

Inspections and tests are performed in accordance with approved procedures, instructions or inspection plans by qualified personnel (*requirements to be established later*) to demonstrate that the quality-affecting SSCs perform satisfactorily in service. These procedures, instructions, and inspection plans contain the following information:

1) References to applicable documents such as drawings, specifications, and procedures

2) Type of inspection to be performed

3) Characteristics and activities to be inspected

4) Individuals or organizations responsible for performing the inspection

5) Requirements and acceptance and rejection criteria (explicit or by reference) obtained from applicable design and procurement documents, specifications, drawings, supplier instructions, and standards

6) Description of the inspection method and equipment to be used, or referenced to an appropriate procedure (including adequate test instrumentation, equipment, calibration

requirements, suitable and controlled environmental conditions, and provisions for data collection and storage)

7) Frequency of inspection or sampling plan

8) Instructions for performing the test

9) Mandatory inspection hold points, if required, for witness by the applicable organization (see additional discussion below)

10) Methods for documenting, recording, verifying, accepting, and maintaining the results of inspections and test as records

11) Records to identify the item examined, date of examination, examiner or data recorder, results, and acceptability (ensuring that all prerequisites for the given test are met), and action taken concerning any deviations noted.

Hold points (e.g., items or activities where inspection is mandatory), witness points, verification points, methods, acceptance criteria, checklists, and other inspection planning documents are established, documented, and implemented to ensure required inspections are performed. Test requirements and acceptance criteria are identified, documented, and approved. Test results are documented and their conformance with acceptance criteria evaluated by the *(position title later*) who have the required qualification requirements (..*to be established later*..) to ensure that test requirements have been satisfied. Independent inspection for acceptance is required for SSCs affecting quality applications.

Reworked items are inspected, tested, or reviewed in accordance with the original requirements. Repaired items are inspected, tested, or reviewed in accordance with requirements approved by the original responsible organization. Replacement items, when used, are inspected, tested, or reviewed in accordance with the above dispositions.

Examinations, measurements, or tests of materials or products processed are performed for each work operation, on a graded approach where necessary, to ensure quality. If direct inspections of items cannot be carried out, indirect control by monitoring processing methods, equipment, and personnel are provided. Both inspection and process monitoring are provided when quality control is inadequate without both methods.

Controls for measuring and testing equipment include calibration and maintenance requirements. Instruments used for inspections and tests are calibrated at specified intervals, before and after use, or just prior to use, as determined by required accuracy, intended use, frequency of use, stability characteristics, and other conditions affecting performance. Instrument calibration certifications are traceable to nationally recognized standards. Instruments are labeled, tagged, or otherwise controlled to indicate calibration status and to ensure traceability to calibration test data. The accuracy of the test equipment ensures that the equipment being calibrated is within the required tolerance and the basis of acceptance is documented and authorized by responsible management.

Instruments found out-of-calibration or out-of-tolerance are tagged or segregated and not used until they are recalibrated. The acceptability of items or processes measured, inspected, or tested with out-of-tolerance instruments is evaluated; measurements and tests are repeated as required.

(Responsibilities of QA and other organizations for establishing, implementing, and ensuring the effectiveness of the calibration and adjustment program for measuring and test equipment will be described in the PSAR.)

3.3.4.8 Management Assessments{tc \l4 "3.3.4.8 Management Assessments}. At least annually, TWRS-P Project management assesses the adequacy of the portions of the QA program that they are responsible for implementing effectively. Management assessments include participation of appropriate levels of line and staff management. Responsibility for conducting the assessment is retained by the manager of the organization.

The assessments cover topics such as strategic planning, project interfaces, cost control, scope, use of performance indicators, adequacy of resources, staff training and qualification, and supervisory oversight and support. Barriers that are hindering the accomplishment of objectives established by the manager to meet TWRS-P Facility quality requirements, are identified, corrective actions determined, and tracked to completion. Follow-up management assessments are conducted to determine the effectiveness of corrective actions.

See Section 3.6, AAudits and Assessments,@ for additional details of the TWRS-P Project management assessment program.

3.3.4.9 Independent Assessments{tc \l5 "3.3.4.9 Independent Assessments}. To maintain quality and to promote improvement, the TWRS-P Project independent assessment program requires 1) the evaluation of item and service quality, requirements compliance, and work performance to determine if the quality systems are producing processes, products, and services that meet or exceed the customers= requirements; 2) a comprehensive independent verification and evaluation of procedures and activities affecting the quality of activities relied upon for safety; and 3) evaluation of suppliers= QA programs, procedures, and activities.

The type of independent assessment performed and the frequency with which an assessment is performed is based on the status, complexity, and importance of the activity or process being assessed, and the past performance of the activity or process being assessed. The independent assessment process incorporates a performance-based approach with emphasis on the results of work processes and compliance with requirements. The independent assessment activity also verifies that functions affecting quality have been correctly performed. The independent assessment identifies

1) Work performance and process effectiveness
2) Off-normal performance and potential problems
3) Improvement opportunities.

These independent assessments are performed using a graded approach and are conducted by staff qualified and knowledgeable in the activity or process being assessed, but who are not directly responsible for the organization, activity, or process. The persons and organizations performing these QA functions have sufficient authority and organizational freedom to identify quality problems; to initiate, recommend or provide solutions; and to verify implementation of solutions. The individuals performing the assessments report to a management level that ensures that the required authority and organizational freedom are provided, which includes sufficient independence from cost and schedule considerations, when these considerations are opposed to safety considerations. The TWRS-P Facility management involvement ensures that activities and reports of the assessment team remain impartial.

Personnel external to BNFL Inc. may perform certain assessments. The external personnel are selected based on their experience and qualifications to provide a different perspective or expertise in functional areas not covered by the BNFL Inc. staff.

A comprehensive system of planned and periodic audits verifies conformance to management controls and other aspects of the QAP including the effectiveness of the program. Audits are performed by qualified personnel not having a direct role in the audited areas.

Independent audit and assessment findings are documented and presented to the management of those organizations responsible for performance of the subject activities or processes. The findings are used by management to formulate corrective actions and to promote improvements. Actions are tracked and adequacy of corrective actions, including those taken to minimize or prevent recurrence, are verified by an independent re-audit, assessment, or surveillance to determine the effectiveness of the corrective actions. Lessons learned are communicated to other TWRS-P organizations with similar activities or concerns. Results of management assessments and independent audits and assessments are subject to review by safety committees as indicated in Section 2.2, ASafety Committees.@

An audit or assessment of the effectiveness of the TWRS-P Facility QAP and QA organization using external team members to BNFL Inc. is performed annually.

3.3.5 Graded Quality Assurance Approach{tc \l3 "3.3.5 Graded Quality Assurance Approach}

The extent to which quality requirements are applied to the TWRS-P Project is reflected in the assignment of QLs using a graded approach. The correct designation and application of QLs ensures that appropriate QA requirements are applied, based on the following considerations:

1) The impact on safety of malfunction or failure of the item
2) The design and fabrication complexity or uniqueness of the items
3) The need for special controls and surveillance over processes and equipment
4) The degree to which functional compliance can be demonstrated by inspection or test
5) The quality history and degree of standardization of the item.

Three quality levels applied by the TWRS-P Project QAP to SSCs and functions are identified below:

1) Quality Level I (QL-1): The highest level of QA requirements applied for protection of public safety and criticality prevention.

2) Quality Level 2 (QL-2): An enhanced level of QA requirements that is less stringent than QL-1 (for protection of the facility and co-located worker) but represents a high level of assurance that an SSC can perform the intended function.

3) Quality Level 3 (QL-3): The application of a standard level of QA requirements that is less stringent than QL-2 but provides reasonable assurance that an SSC will perform its intended function.

3.3.6 Application of Graded QA to SSCs, Processes, and Activities{tc \l3 "3.3.6 Application of Graded QA to SSCs, Processes, and Activities}

The design classification of SSCs is based on their importance to accident prevention and mitigation using the results from the hazard identification and accident analysis processes discussed in Chapter 4.0, AIntegrated Safety Analysis.@ This design classification ensures that each SSC is designed, constructed, fabricated, installed, tested, operated, and maintained to quality requirements consistent with the importance of the function that needs to be performed.

Design Class I SSCs are those necessary to ensure that the radiation and chemical exposure standards for members of the public are not exceeded as a result of credible accidents. Design Class I SSCs provided to protect the health and safety of the public for accident conditions provide adequate protection to the environment. Design Class I is also applied to those SSCs necessary to prevent criticality events although criticality is not considered a credible event for the TWRS-P Facility. The highest levels of design, QA, and operational requirements are applied to Design Class I SSCs. The Design Class I SSCs are designed to perform their safety function assuming the failure of any single active component. Design Class I SSCs are also physically protected so that the failure of another SSC does not prevent the performance of the specified safety function. The level QL-1 is applied to all Design Class I SSCs.

When an SSC is designated as Design Class I:

1) It receives the highest level of Quality Assurance

2) Active systems and components are provided single failure protection

3) General and specific design, maintenance, and testing requirements are to the SSC are applied as identified in the SRD

4) Other requirements may be applied to the SSC based on the specified safety function for the SSC

5) It is designed to withstand any severe natural phenomena hazard (NPH) when the NPH may be an initiating event

6) It receives the highest level of operational requirements, including periodic testing, preventative maintenance, and application of TSRs.

The SSCs necessary to ensure that the radiation and chemical exposure standards for facility and co-located workers are not exceeded as a result of credible accidents are designated as Design Class II. An enhanced level of design, QA, and operational requirements are applied to Design

Class II SSCs. They are designed to requirements that meet or exceed the codes and standards required by the State of Washington and the Uniform Building Code (UBC) (ICBO 1994). Design Class II SSCs are physically protected so that the failure of another SSC does not prevent the performance of the specified safety function. Defense-in-depth is applied to ensure adequate protection of facility and co-located workers. The level QL-2 is applied to all Design Class II SSCs.

When an SSC is designated as Design Class II:

1) It receives a high level of Quality Assurance

2) Defense in-depth is applied but single failure protection is not mandated

3) General and specific design, maintenance, and testing requirements are applied to the SSC as identified in the SRD

4) Other requirements may be applied to the SSC based on the specified safety function for the SSC

5) It is designed to withstand severe any NPH when the NPH may be an initiating event

6) A high level of operational requirements are applied, including LCRs.

All SSCs not classified as Design Class I or II are classified as Design Class III. These SSCs are not credited in accident analyses for protection of the public or workers; however, many enhance the safety of the facility by reducing challenges to safety functions. Other SSCs ensure that the public and worker exposure to radiological, nuclear, and process hazards is ALARA during normal and maintenance functions. Commercial design, QA, and operational codes and standards required by the State of Washington and the UBC (ICBO 1994) are applied to Design Class III SSCs.

The QL-2 designation is also applied to specific Design Class III SSCs, as needed, to ensure increased reliability and investment protection or to satisfy other project performance criteria. The remainder of the Design Class III SSCs are designated as QL-3, representing the application of a standard level of QA requirements.

Table 3-2 presents a typical application matrix developed to relate the requirements of the QAP to the QL of SSCs. The matrix is provided as a guide with regard to the application of a graded approach process.

Table 3-2. Application of Quality Assurance Program Requirements for QL-1, QL-2, and QL-3 Structures, Systems, and Components. (Sheet 40)

QAP Requirement	QL-1	QL-2	QL-3	Remarks
1. Program				
$ A written Quality Assurance Program (QAP) is developed, implemented, and maintained.	X	X	Xa	A QAP describing selected criteria (as applicable) of 10 CFR 830.120 is acceptable.
$ The QAP describes the organizational structure, functional responsibilities, level of authority, and interfaces for those managing, performing, and assessing the work.	X	X		
$ The QAP describes management processes, including planning, scheduling, and resource consideration.	X	X		
2. Personnel Training and Qualification				
$ Qualification of personnel: policies and procedures that describe personnel selection requirements are established for each position.	X	X		
$ Training provides knowledge of the correct processes and methods to accomplish assigned tasks.	X	X		
$ Training goals, lesson plans, and other training materials are developed, reviewed by subject matter experts, and approved by management.	X	X		
$ Training effectiveness is monitored. Worker performance is evaluated to ensure that the training program conveys all required knowledge and skills.	X	X		
3. Quality Improvement				
$ Process to detect and prevent quality problems is established and implemented.	X	X		Commercial practices for QL-3
$ Items, services, and processes that do not meet established requirements	X	X		Commercial practices for QL-3

Table 3-2. Application of Quality Assurance Program Requirements for QL-1, QL-2, and QL-3 Structures, Systems, and Components. (Sheet 40)

QAP Requirement	QL-1	QL-2	QL-3	Remarks
are identified, controlled, and corrected according to the importance of the problem and the work affected.				
$ Correction includes identifying the causes of problems and working to prevent recurrence.	X	X		Commercial practices for QL-3
$ Item characteristics, process implementation, and other quality-related information are reviewed and the data analyzed to identify items, services, and processes needing improvement.	X	X		Commercial design practices for QL-3
4. Documents and Records				
$ Documents are prepared, reviewed, approved, issued, used, and revised to prescribe processes, specify requirements, or establish design.	X	X		Commercial practices for QL-3
$ Records are specified, prepared, reviewed, approved, and maintained.	X	X		Commercial practices for QL-3
5. Work Processes				
$ Work is performed to established technical standards and administrative controls using approved instructions, procedures, or other appropriate means.	X	X		Commercial practices for QL-3
$ Items are identified and controlled to ensure their proper use.	X	X		Commercial practices for QL-3
$ Items are maintained to prevent their damage, loss, or deterioration.	X	X		Commercial practices for QL-3
$ Equipment used for process monitoring or data collection is calibrated and maintained.	X	X		Commercial practices for QL-3
6. Design				
$ Design inputs are technically correct and complete. These inputs may	X	X		Commercial design practices for QL-3

Table 3-2. Application of Quality Assurance Program Requirements for QL-1, QL-2, and QL-3 Structures, Systems, and Components. (Sheet 40)

QAP Requirement	QL-1	QL-2	QL-3	Remarks
include such information as design basis, health and safety considerations, performance parameters, codes and standards requirements, and reliability requirements.				
$ Technical design interfaces are identified in the input documents and methods are established for their control.	X	X		Commercial design practices for QL-3
$ The design process translates design input into design output documents that are technically correct and meet the end-user=s requirements.	X	X		Commercial design practices for QL-3
$ Aspects critical to the safety or reliability of the designed system, structure, or component are identified during the design phase.	X	X	Xa	Commercial design practices for QL-3
$ Computer software verification and validation.	X	Xa		
$ The completed design is recorded in design output documents such as: drawings, specifications, test/inspection plans, maintenance requirements, and reports.	X	X		QL-3: drawings, specifications, calculations only
$ Design verification is a formal documented process to establish that the resulting SSC will be fit for the intended use. Design verification methods include, but are not limited to, technical reviews, peer reviews, alternate calculations, and qualification testing.	X	X		Commercial design practices for QL-3
$ The adequacy of design products is verified or validated by an individual or groups other than those who performed the work.	X	Xa		
$ Design changes, including field	X	Xa		Independent design verification is

Table 3-2. Application of Quality Assurance Program Requirements for QL-1, QL-2, and QL-3 Structures, Systems, and Components. (Sheet 40)

QAP Requirement	QL-1	QL-2	QL-3	Remarks
changes and nonconforming items dispositioned Ause-as-is@ or Arepair,@ are controlled by measures commensurate with those applied to the original design.				not required for QL-2; commercial design practices for QL-3
$ Temporary modifications receive the same levels of control as the designs of permanent modifications.	X	X		Commercial design practices for QL-3
7. Procurement				
$ Prospective suppliers are evaluated and selected on the basis of specified criteria.	X	Xa		
$ Procurement documents clearly state test/inspection requirements and acceptance criteria for purchased items and service.	X	X		Commercial practice for QL-3
$ Supplier monitoring.	X	Xa		Supplier monitoring is not mandatory during the procurement process for QL-2
$ Receipt inspection.	X	X	X	
$ Reporting nonconformances.	X	X	X	
$ Product documentation: Supplier-generated documents that are important to the product quality are accepted through the procurement system and controlled; these documents may include certificates of conformance, drawings, analysis, test reports, maintenance data, nonconformances, corrective actions, approved changes, waivers, and deviations.	X	X		
8. Inspection and Acceptance Testing				
$ Inspection and testing of specified items, services, and processes is conducted using established	X	X	Xa	

Table 3-2. Application of Quality Assurance Program Requirements for QL-1, QL-2, and QL-3 Structures, Systems, and Components. (Sheet 40)

QAP Requirement	QL-1	QL-2	QL-3	Remarks
acceptance and performance criteria.				
$ Equipment used for inspections and testing is calibrated and maintained.	X	X	Xa	
9. Management Assessment				
$ Managers assess their management processes. Planned and periodic management assessments are established and implemented. Problems that hinder the organization from achieving its objectives are identified and corrected.	X	X		
10. Independent Assessment				
$ Independent assessments are planned to measure item and service quality.	X	X		
$ The group performing independent assessment have sufficient authority and freedom from the line organization to carry out its responsibilities.	X	X		
$ Persons conducting independent assessments are technically qualified and knowledgeable in the areas assessed.	X	X		

X = Full application of the QAP requirement
Xa = Graded application of QAP requirements

(*Additional detail will be added to the this section in the PSAR and the FSAR. This information will include a summary of the information in Chapter 4.0 for the QA requirements of each SSC and a description how requirements will be achieved. The information will also demonstrate that the quality, configuration management and maintenance programs are coordinated and that the QAP is an integral part of everyday work activities.*)

3.4 TRAINING AND QUALIFICATION{tc \l2 "3.4 TRAINING AND QUALIFICATION}

Personnel training and qualification is viewed by TWRS-P Facility management as essential in achieving quality performance and in protecting workers and the environment. The General Manager has the overall responsibility for maintaining a qualified workforce at the facility, and the Operations and Technical Support Manager is responsible for developing and implementing facility training programs. The required content for effective facility training and qualification programs is described in DOE/RL-96-0006 (DOE-RL 1996c), Section 4.3.4, and other specific topical sections. Table S4-1 of the TWRS-P Facility contract requires the submittal of a training and qualification plan. These training and qualification standards and the training system described in this section apply to TWRS-P Facility personnel and subcontractor employees performing operations, maintenance, and technical support work at the facility. The application of the systematic approach to training is tailored, commensurate with the importance to safety of the tasks for which the personnel are being trained. BNFL Inc. and its subcontractors conduct their established training programs in areas such as industrial safety, fire protection, and QA during the design and construction phases of the project.

3.4.1 Introduction{tc \l3 "3.4.1 Introduction}

The goal of training is to ensure that personnel engaged in activities affecting safety attain the ability to work safely and are qualified to perform their duties. Specific objectives of training include understanding processes to improve technical ability, increasing awareness of hazards and the value of engineered and administrative controls that function to prevent and mitigate the hazards and hazardous situations, enhancing communication skills and effectiveness of supervision, demonstrating worker qualifications and the ability to use administrative controls to respond to hazardous situations, and establishing a safety culture. The training system described herein incorporates these objectives and serves as the primary management tool for analyzing training needs, and designing, developing, conducting, and evaluating training. *(Qualification criteria will be developed for this section in the PSAR.)*

The types of training provided at the TWRS-P Facility fall into the following general categories:

1) Regulations applicable to establishments that handle radioactive and hazardous material require that all personnel, including subcontractors and visiting personnel, are trained in how to conduct themselves on the site, respond to alarms, and use personal protective equipment and emergency response equipment, depending on the nature of their work.

2) Employees new to the facility require training to a minimum level of awareness and capability to perform their assigned duties.

3) Performance-based specialized training is provided for key personnel employed in particular operations, maintenance, technical support, and supervisory positions, tailored to their involvement with Design Class I and II SSCs.
4) Training specific to facility or process modifications and new technology is provided, or training is provided when personnel are transferred to new areas of work.

5) Special training is provided, if required, when normal skills and expertise are to be employed in unusual circumstances, such as during nonroutine maintenance infrequently performed activities or in response to emergencies.

6) Refresher training in routine activities (e.g., radiation protection) is provided to ensure that competency is maintained.

3.4.2 Organization and Management of the Training System{tc \l3 "3.4.2 Organization and Management of the Training System}

The facility is staffed and managed to effectively plan, administer, evaluate, and control a systematic process that accomplishes job-related training needs. The training and qualification system is formally documented and implemented as described in TWRS-P Facility procedures and instructions to ensure that training activities are consistently and effectively conducted. Facility procedures clearly define the responsibilities and roles, authority, and accountability of personnel involved in managing, supervising, and implementing training programs. Specific facility instructions describe the qualification and requalification process, personnel selection requirements, procedures for development and control of training materials, conduct of OJT, control of on-shift training, conduct of drills, and administration of training examinations.

Line managers, in conjunction with operations and technical support training personnel, have the primary responsibility for effective conduct of the training programs and are responsible for providing the resources necessary for their staff to participate in training required for their job function. TWRS-P Facility management is actively involved in the implementation of training programs by providing appropriate performance objectives and approvals regarding training needs and the content of instructional materials. In addition to ongoing performance monitoring by line management, periodic assessments are conducted as part of the training program evaluation process to ensure consistency, effectiveness, and efficiency of the training system.

3.4.3 Training Plan{tc \l3 "3.4.3 Training Plan}

The TWRS-P Facility training plan (*...to be developed in Part B...*) incorporates the training objectives stated in Section 3.4.1 AIntroduction@ and describes the initial, continuing, and refresher training requirements for key personnel whose level of knowledge and skill is important to safe facility operation. The training plan also contains minimum education, experience, and medical (if applicable) requirements for each identified position and specifies the training and any special qualifications that are required. As a minimum, formal training is provided to the following personnel:

1) Facility staff members (e.g., basic radiological, chemical, criticality, industrial safety)
2) Process operators
3) Technicians (e.g., laboratory, radiological control)

4) Maintenance personnel
5) Emergency response personnel
6) Supervisors and managers
7) Technical instructors
8) Visitors allowed unescorted access
9) QA personnel
10) Subcontractor employees who perform any of the above jobs at the facility.

3.4.4 Initial and Continuing Training Programs{tc \l3 "3.4.4 Initial and Continuing Training Programs}

Initial and continuing training programs are established for operations, maintenance, and technical support personnel to ensure that these individuals are qualified to perform job requirements and to maintain proficiency, and maintain safe facility operations. Classroom and OJT is conducted by designated, qualified individuals. Qualifications for instructional personnel are specified in the training plan. Personnel new to the TWRS-P Facility or changing to positions for which they have not received training complete training within six months after starting the assignment. Personnel who have not received training can work only under the supervision of trained personnel.

Individual training programs are tailored to match the employee's role in the organization and specify minimum amounts and types of training and testing that must be completed before qualification is granted. Operations personnel in training are supervised and controlled to ensure the appropriate information is being learned, to rely on engineered features, to avoid mistakes in operations, and to use trainee time effectively. Exceptions from training are granted when justified and approved by management; the exception process is controlled by TWRS-P Facility procedures (*to be developed in Part B).*

Depending on job duties, initial training, consists of the appropriate combination of required reading, self-study, classroom lectures, computer-based training (CBT), OJT, and performance evaluations. Facility control system simulators and prototype melters are used, as appropriate, to provide a low-risk training environment for operational and maintenance personnel to support testing activities. Initial training programs include, as applicable, training on basic theory and fundamentals, principles of facility operation and operating characteristics, facility systems, and normal, off-normal, and emergency operating procedures.

Continuing training programs are designed to maintain and enhance the knowledge and skills of operations, maintenance, and technical support personnel who perform or support functions that affect safety. Continuing training is administered on a two-year cycle and also includes an appropriate combination of required reading, self-study, classroom training, CBT, OJT, and performance evaluations. Training content is tailored to the position and may include topics that cover significant changes to facility, SSCs, procedure changes; lessons learned; training to correct identified performance problems; and selected fundamentals, including seldom-used knowledge and skills necessary to ensure safety. For emergency responders, training also includes drills on off-normal or accident situations and use of facility systems to control or mitigate accidents.

Each employee involved in operating a process is trained in an overview of the process and in the operating procedures and instructions. The training includes emphasis on the specific safety and health hazards, operating limits, emergency operations including shutdown, and safe work practices applicable to the employee=s job tasks.

Refresher training is provided at least every three years for PSM activities, and more often if necessary, to each employee involved in operating a process to assure that the employee understands and adheres to the current operating procedures and instructions of the process and is proficient in the procedures to follow if conditions exceed the design basis of the facility.

3.4.5 Training Design and Development{tc \l3 "3.4.5 Training Design and Development}

BNFL Inc.=s performance-based training system provides a comprehensive approach for the development, conduct, and evaluation of training programs. A systematic approach that defines competent job performance through tasks and related knowledge and skills and then allows students to practice or demonstrate competency during training is used. Performance-based training includes five general phases: analysis, design, development, implementation, and evaluation. Wherever practical, alternative methods are used to streamline all phases of this systematic approach to training. This systematic approach to training, as it is applied in the TWRS-P Facility, is formally developed and documented in TWRS-P Facility instructions. Using the systematic approach to training ensures that the facility training system achieves the following:

1) Bases training on a systematic analysis of each job position - The training staff and relevant technical experts develop a list of tasks that require training by using available job information such as procedures, TSRs, LCRs, and equipment and system operating manuals.

2) Uses learning objectives derived from the analysis - Learning objectives are defined during the design phase of the systematic approach to training. Action statements that describe the desired post-training performance by using the task list are developed.

3) Evaluates trainee mastery of objectives during training - Trainee mastery is evaluated by administering oral or written tests at the end of most courses, and by measuring student behavior in terms of the skills, knowledge, and attitudes exhibited in the operational environment.

4) Bases evaluation and revisions on the job performance of trainees - Through ongoing performance monitoring, and by observing facility events, reviewing industrial accident reports, and interviewing personnel, tasks can be identified in which inadequate training may be contributing to equipment damage, unscheduled maintenance, unsafe practices, or nonadherence to approved procedures.

3.4.5.1 Training Materials Development{tc \l4 "3.4.5.1 Training Materials Development}. Personnel knowledgeable of the design and process functions use the information obtained in the analysis and design phases to develop training materials that accomplish the learning objectives. Training materials may include lesson plans, student guides, handouts, software, and written, oral, or performance evaluations. Lesson plans or equivalent training guides are developed to provide guidance and to ensure consistent presentation of in-class training and OJT. Lesson plans typically include the following elements:

1) Learning objectives

2) Instructor preparation guidelines
3) A list of the training aids and materials used in the lesson
4) Safety precautions and procedural limitations
5) References
6) A list of prerequisite training
7) Presentation methods
8) Evaluation methods.

Examinations (e.g., oral, written, performance) are prepared during the development phase to provide a means to objectively assess student mastery of the material. Examination design includes a review of the test item data from the design phase, a comparison of the learning objectives and test items as stated in the lesson plan, and development of a test specification table to ensure that the student has met the learning objectives in terms of knowledge, comprehension, and application.

3.4.5.2 Modification of Training Materials and Procedures{tc \l4 "**3.4.5.2 Modification of Training Materials and Procedures}**. Effective training programs reflect current operating practices, conditions, and procedures. To ensure that training properly reflects operating practices and procedures, a process to maintain training materials current tracks items that may affect the content of TWRS-P Facility training programs and materials. This process is accomplished primarily through the facility=s configuration management and permits the training staff to respond to the need for changes resulting from new or revised regulatory requirements, safety analyses, TSRs, LCRs, procedure changes, changes in facility equipment configuration, lessons learned information, and resolution of audit findings. Modification of training administration procedures is also subject to the controls of configuration management. The content of training materials is revised using the same process that is used to develop new training materials.

The need to modify training materials may also be identified as part of the periodic review process or as a training deficiency identified by students, instructors, operations or maintenance staff, management, or oversight groups. Additionally, training packages are reviewed after any significant program change and are updated to ensure that information in the training package is current with facility operations. Changes to training program content, together with the reason for the changes, are documented in the facility training files.

3.4.6 Evaluation of Training Programs{tc \l3 "3.4.6 Evaluation of Training Programs}

Training and qualification programs require a significant investment in equipment, materials, and personnel resources. Periodic systematic program evaluations are conducted to measure the training system=s effectiveness in producing competent employees in a consistent, cost-effective manner. Training program evaluations can identify program strengths and weaknesses, determine if worker performance has improved, assess if program content matches current job needs, and determine if corrective actions are needed to improve program effectiveness. It is line management=s responsibility to lead training program evaluations and to implement corrective actions to make identified needed improvements. Program evaluations are conducted on an established schedule and may consist of an overall evaluation or a series of topical evaluations over a period of time.

Evaluation objectives that are applicable to the training program or topical area being reviewed are developed, and may address the following elements of training:

1) Management and administration of training and qualification programs
2) Development and qualification of training staff
3) Trainee entry-level requirements
4) Determination of training program content
5) Design and development of training programs
6) Conduct of training
7) Trainee examinations and evaluations
8) Training program assessments and evaluations.

Evaluation results are documented and highlight noteworthy practices and weaknesses in the training program. Identified deficiencies are reviewed, improvements are recommended, and changes are made to procedures, practices, or training materials, as necessary.

3.4.7 Training Records{tc \l3 "3.4.7 Training Records}

Auditable records are maintained through the TWRS-P Facility document control system on individual employee training completions, job performance, and fitness for intended duty. These records also include training documentation for subcontractor employees that work at the facility. Records of training development and evaluations are maintained in training program files. Training records, both programmatic and individual, support management information needs. Information such as courses completed, training expiration dates, and summary reports is routinely provided to management to facilitate training analysis, planning, and scheduling activities. Record keeping requirements are described in more detail in Section 3.8, ARecords Management.@

3.5 HUMAN FACTORS{tc \l2 "3.5 HUMAN FACTORS}

Human factors is the application of knowledge about human performance capabilities and behavioral principles to the design, operation, and maintenance of human-machine systems so personnel can function at their optimum level of performance. The design philosophy emphasizes the use of engineered features over administrative controls as human actions. However, the incorporation of human factors considerations into the facility design and operational process ensures that human contribution to operational success is enhanced while off-normal situations resulting from human error are reduced. Facility design and operations that include insights from a human factors perspective help to ensure that facility and equipment design, staff capabilities, and operational procedures are combined to enhance human performance while protecting against susceptibility to human error. Human performance is an element of the defense-in-depth philosophy of the TWRS-P Project.

3.5.1 Organization and Administration{tc \l3 "3.5.1 Organization and Administration}

The human factors considerations for the design and operation of the TWRS-P Facility are identified in this section as they relate to the safety of the TWRS-P Facility. The aspects of the TWRS-P Project that ensure the application of human factors knowledge are described below.

3.5.1.1 TWRS-P Facility Human Factors{tc \l4 "3.5.1.1 TWRS-P Facility Human Factors}. The TWRS-P Project Operations and Technical Support Manager is responsible to recommend and coordinate actions to ensure that human factors principles and processes are adequately contained in the TWRS-P Project safety policies, processes, procedures, training, and designs. *(Qualifications, expertise, experience, training and authorities of this position will be established and contained in this section of the PSAR.)*

The TWRS-P Project human factors emphasis is focused on the human-machine interfaces required for ensuring the safety function of Design Class I and II SSCs or functions. Human factors are considered in TWRS-P Facility operations where humans are relied upon for preventive actions (e.g., system operations, surveillance testing, and maintenance activities during normal operations) and for mitigative actions during off-normal and emergency operations.

The extent of the application of human factors is based on a tailored approach commensurate with extent of the human interaction, the overall design effort, and the risk associated with human performance failures. The majority of the activities required to implement the human factors occur during the design, construction, and testing phases of the TWRS-P Project.

3.5.1.2 TWRS-P Facility Human Factors Reviews{tc \l4 "3.5.1.2 TWRS-P Facility Human Factors Reviews}. A TWRS-P Facility human factors specialist conducts human factors reviews of training, operator capabilities, and designs of the TWRS-P Facility Design Class I and II SSCs and functions that are judged to be critical to facility performance and that have a high potential for human error. These reviews are performed at several stages during the project. The specialist evaluates work spaces, human-machine interfaces, training, and organizations to determine their suitability. The specialist considers whether information provided to support human performance is directly and easily usable or requires processing before decisions are made by the operator. The specialist also evaluates TWRS-P Facility ongoing and planned initiatives to ensure continuing human factors assessment and improvements. *(Qualifications, expertise, experience, training, and authorities of the human factors specialist will be established and contained in this section of the PSAR.)*

During the initial phases of the project, the human factors specialist identifies deficiencies and provides recommendations to better address the human factors principles and processes in these areas. The TWRS-P Project management is responsible for evaluating the information and the implementation of recommendations that are needed to incorporate human factors improvements into the facility.

3.5.2 TWRS-P Facility Human Factors Assessment and Correction of Deficiencies{tc \l3 "3.5.2 TWRS-P Facility Human Factors Assessment and Correction of Deficiencies}

NUREG-1358, *Lessons Learned from the Special Inspection Program for Emergency Operating Procedures: March - October 1988* (NRC 1989a), determined the following:

> "When systems are designed to incorporate a human operator as a system component, there are basic, interdependent factors that must be properly addressed if the system is to perform its function successfully. These factors are 1) operator capabilities, 2) procedures, 3) facility/equipment design, and 4) training."

The interdependency of these and other factors are incorporated into the TWRS-P Facility design and functions to optimize the human-machine interfaces as discussed below.

3.5.2.1 Operator Capabilities{tc \l4 "3.5.2.1 Operator Capabilities}. Section 4.6, AIntegrated Safety Analysis Methods@; Section 4.7, AResults of the Integrated Safety Analysis@; and the HAR are used to identify human actions needed to safely operate the facility. Task analyses are performed on operations required to maintain the safety functions of the facility and that involve personnel. This evaluation includes analyzing the demands on the operating personnel in terms of perception, decision making, and action. The analyses provide an assessment of the feasibility of the proposed tasks and an input to the design of interfaces to accommodate expected human capabilities. The results of such task analyses also provide the basis for developing operating procedures and personnel training.

Personnel with safety responsibilities are provided with expectations for their safety functions. These expectations include the responsibilities of the operations personnel who monitor and control facility response to faults as well as the responsibilities of those personnel who perform tests, maintenance, or other activities. Qualification criteria define the experience, education, and training required to perform a designated task.

As described in Section 3.4, ATraining and Qualification,@ the TWRS-P Project training program is performance-based. For example, operator training and performance is evaluated by TWRS-P Facility management throughout the startup testing program. The operator interactions with the procedures and equipment are evaluated to identify potential human factors problems.

3.5.2.2 Procedures{tc \l4 "3.5.2.2 Procedures}. Human errors are minimized when procedures are accurate and easy to read and follow. As discussed above, the demands on the operating personnel in terms of perception, decision making, and action are analyzed to evaluate the feasibility of the proposed tasks and provide an input to the design of interfaces in accordance with human capabilities. The task analyses of the processes also support the development of the operating procedures. Operators and maintenance personnel participate in procedure writing and the review process. This participation permits the inclusion of operational experience and human factors considerations into procedures and ensures that operators and maintenance personnel needs and limitations are carefully considered and incorporated. The validation and verification of procedures, as discussed in Section 3.9, AProcedures,@ also support the incorporation of human factors considerations into the procedures.

3.5.2.3 Facility and Equipment Design{tc \l4 "3.5.2.3 Facility and Equipment Design}. The conceptual and detailed design for the TWRS-P Facility are completed in accordance with TWRS-P Facility functions, requirements and performance specifications. Section 4.6, AIntegrated Safety Analysis Methods@; Section 4.7, AResults of the Integrated Safety Analysis@; and the HAR are used during the design stage to identify and to assess areas of potential hazards and hazardous situations to the facility workers, the public, and the environment. The process identifies the various operational steps to be conducted within the TWRS-P Facility and by doing so, considers human interactions with machines. The analysis identifies both engineered and administrative mitigating controls. Throughout the facility and equipment design process, careful attention is given to human factors and ergonomic practices to provide an optimal assignment of functions that maximize the capabilities of both humans and machines. Appropriate human factors to improve human performance through enhancements in the work environment and in human-machine interfaces are applied on a tailored approach in the design, operation, and maintenance of the TWRS-P Facility. Verification that human factors issues are incorporated into the TWRS-P Facility design is an element of the defense-in-depth design process.

The design process includes human factors design analyses that encompass design criteria such as system performance criteria, safety, cost, training, scheduling, environmental considerations, physical layout, warning features, communications, and other factors that serve to minimize errors of omission and commission and to ensure that the operator is able to respond to situations in which human response is required. Human factors principles are applied at the TWRS-P Facility to reduce the potential of hazardous situations caused or exacerbated by human error and to enhance the potential of appropriate and timely human actions to mitigate events. Appropriate and timely response to adverse conditions or events provide defense-in-depth to the workers, the public, and the environment.

Designs of control rooms and local control stations ensure that adequate instrumentation and controls provided clear and unambiguous indications of TWRS-P Facility status so that operators can detect and correct off-normal conditions. Display systems, panel layouts, and workspace access for maintenance and the local physical environment designs ensure routine and special maintenance can be safely completed. The acceptability of instruments placement is confirmed by constructing a physical or computer mockup of the panels before fabricating the panels. This mockup ensures that the panels are compatible with human psychology and physical characteristics and enable the operators to perform their tasks reliably and efficiently.

Not all Design Class I or II SSCs require a high degree of human-machine interface. For these less-complex components or systems of the TWRS-P Facility (i.e., systems that do not have a high potential for human error or require extensive human-machine interfaces), the effort of performing a formal human factors analysis may outweigh the benefits. Therefore, a less detailed human factors evaluation is conducted for these portions of the TWRS-P Facility. This less-detailed human factors evaluation is conducted on the basis of safety importance, complexity, cost, and degree of human machine interface. These evaluations are performed in accordance with approved procedures. (*Procedures will be developed during Part B*.)

BNFL Inc. has an established and comprehensive work management process, as discussed in Section 3.1, AConfiguration Management,@ to ensure that work activities affecting facility operations are managed safely and effectively. This work management process prevents the implementation of design changes (i.e., construction and installation) until after the engineering department has completed the final design. As the facility moves through startup into the operational phase, the configuration management process ensures that human factors principles and policies are applied to modifications of SSCs or functions. Human factors principles are applied to the procurement of new material and services, changes or repairs to existing SSCs, and the integration of the new or modified system with the original set of operational equipment. Design changes that are completed after the facility is operational also address human factors elements such as pre-work planning, training, and procedures that may be affected by the proposed modifications.

3.5.2.4 Personnel Training{tc \l4 "3.5.2.4 Personnel Training}. For training purposes, the human factors reviews focus on incorporating task analysis information into OJT material and ensuring that operators are trained and evaluated on this material. As discussed in Section 3.4, ATraining and Qualification,@ the TWRS-P Project training organization applies performance-based training to specific jobs.

In addition to classroom instruction and OJT operational drills and exercises are an effective means of training personnel to respond to off-normal conditions and situations. Operational drills and exercises provide an assessment tool to help management evaluate the staff's response. During the observation of the operators during training, drills, and exercises, human factors elements are also considered, to develop potential modifications to the training, the procedures, or the facility.

3.5.2.5 Correction of Deficiencies{tc \l4 "3.5.2.5 Correction of Deficiencies}. As discussed in Section 3.3, AQuality Assurance,@ the design process and the reviews of the design verify the applications of human factors principles to the design. Identified deficiencies are evaluated to determine if the design must be changed to address the problem. Human factors deficiencies identified following the completion of the final design are resolved under the configuration management process or the corrective action program. Controlling the identification and the resolution of deficiencies with the two programs ensures that management=s attention is directed toward the concerns in a timely manner.

3.5.3 Lessons Learned Applications{tc \l3 "3.5.3 Lessons Learned Applications}

The human factors process involves collecting lessons learned from experience in the commercial nuclear industry, DOE facilities, and from relevant events in other industries. The lessons learned information is assessed to ensure that any specific failing in the human-machine interaction that may be applicable to the TWRS-P Facility design are addressed. This process allows the TWRS-P Facility design team to build on the valuable lessons learned from the experiences of others.

The lessons learned program is initiated during the design and construction phase of the TWRS-P Project. Initially, the majority of the information is based on the experience BNFL has gained from similar facilities. As the design matures, the program expands to other industries and DOE facilities. Before the facility is placed into operation, lessons learned serve as input to: the TWRS-P Facility safety policy; TSRs and LCRs; training and qualification; and engineering, operations, maintenance, and other applicable procedures. Applicable human factors lessons learned are incorporated into various aspects of the TWRS-P Facility design, from the regulatory requirements and design requirements down to operating procedures and training requirements.

The evaluation of human factors from incidents at the TWRS-P Facility and other facilities are included in of the lessons learned program that is discussed in more detail in Section 3.7, AIncident Investigations.@

3.6 AUDITS AND ASSESSMENTS{tc \l2 "3.6 AUDITS AND ASSESSMENTS}

The QA organization evaluates the effectiveness of the TWRS-P Project safety management program and policies through the implementation of an audits and assessments program. The audits and assessments program 1) provides for the determination of item and service quality, requirements compliance, and work performance, and 2) promotes improvement to ensure that the established level of protection is maintained for the workers, public, and the environment. The audits and assessments are intended to determine the effectiveness of the implementation of the quality program and the identification of deficiencies.

The audits and assessments program encompasses audits, surveillances, independent assessments, management assessments, and performance monitoring. Audits and independent assessments are performed by designated personnel who are independent of direct responsibility for performing the activities that they audit or assess. The audit and independent assessment personnel have authority and organizational freedom from direct pressures resulting from operational concerns.

3.6.1 General Information{tc \l3 "3.6.1 General Information}

The Project Quality Assurance Manager (PQAM) is responsible for the development and the implementation of the audits and assessments program. During design and construction, the PQAM reports directly to the Corporate (BNFL Inc.) Quality Assurance Manager and has direct access to the TWRS-P Project Manager. The PQAM has the responsibility to verify that the TWRS-P Project activities are performed in accordance with the applicable regulatory requirements, the BNFL Inc. Quality Assurance Program (QAP) (BNFL 1997a), and the codes and standards specified in the SRD. Additional roles and authorities, e.g., program reviews and stop work authority, are discussed in Section 2.1, AOrganization and Administration,@ and Section 3.3, AQuality Assurance.@ The structure of the TWRS-P Project organization provides management control and lines of communications between the prime contractor and principal subcontractors for quality program activities.

(Changes to the TWRS-P Project organizational structure are expected during the evolution from this ISAR to the PSAR and the FSAR. Information relative to the QA organization structure, as it relates to audits and assessments, will be incorporated into Section 3.6 of the PSAR and FSAR.).

The audits and independent assessments are performed in accordance with approved procedures by qualified and knowledgeable staff in the activity or process being assessed and who have sufficient authority and freedom from the line organizations to carry out the responsibilities. The basis for the sampling frequency of TWRS-P Project technical and administrative attributes is established and factored into the scope and scheduling of audits and assessments.

The TWRS-P Project QA staff conducts periodic audits and independent assessments of subcontractors and suppliers to ensure that regulatory and contractual obligations are being met with regard to quality of products or services that could have an adverse effect on workers, public safety, or the environment.

The results of audits and assessments are documented and reviewed by management having responsibility in the areas being audited. Corrective actions are developed and implemented and follow-up action is taken, including a follow-up audit or assessment of deficient areas to preclude recurrence.

The TWRS-P Project, the subcontractors, and suppliers are subject to the *Price-Anderson Amendments Act* (PAAA) provisions contained in 10 CFR 820, AProcedural Rules for DOE Nuclear Activities.@ The deficiencies identified in audits and assessments are evaluated to determine if they represent a PAAA nuclear safety requirement noncompliance as defined by 10 CFR 820. Appropriate TWRS-P Project management is informed of the results of the evaluation, and appropriate action is initiated in accordance with TWRS-P Project procedures.

The TWRS-P Project staff maintains a continuing interaction with the TWRS-P Project regulator. The purpose of this communication is to ensure that the regulator is informed and agrees with the way in which safety conditions are met; that applicable laws and legal requirements are met; that TWRS-P Project staff is conforming to the DOE-stipulated, top-level safety standards and principles; the SRD; and that the status and conditions of TWRS-P Project regulatory approvals are discussed.

A records management system provides for the control of the deficiencies reports, corrective action reports, and evaluation report of the effectiveness of corrective actions to preclude recurrence. These deficiencies include those identified as a result of internal and external audits, assessments, and surveillances; inspections; evaluations; and performance monitoring.

3.6.2 Independent Assessments{tc \l3 "3.6.2 Independent Assessments}

Independent assessments are required by 10 CFR 830.120 to measure the effectiveness of TWRS-P Project program activities in achieving worker and public safety and environmental protection. The personnel performing the assessments have the authority and freedom from the line organization to carry out the assigned responsibilities. The independent assessment process is described in procedures. Independent assessments are performed to identify the following items:

1) Work performance and process effectiveness
2) Off-normal performance and potential problems
3) Improvement opportunities
4) Effectiveness of corrective actions in preventing recurrence of previous problems.

The scope, type, and frequency of independent assessments performed is based on the following conditions:

1) Complexity and importance of the activity or process being assessed

2) Past performance of the activity or process being assessed

3) Performance indicator and trending results

4) High deficiency rate of technical and administrative areas found by DOE or NRC inspections at other facilities.

Examples of areas to be assessed include:

1) Health, safety, and environment, safety, and health (e.g., radiation and process safety, fire protection, and environmental protection), QA, engineering design, development and maintenance of the TWRS-P Project design basis, configuration management, organizational interfaces, procurement, operations, maintenance, training, human factors, procedure compliance, corrective action process, SARs, TSRs, and LCRs.

2) Hazardous waste management (dangerous waste permit conditions), waste labeling and handling practices, waste storage, treatment, transportation and manifests, inspection program, personnel training, and emergency response

3) Air pollution control (permit or registration conditions, conformance with air emission standards, and equipment maintenance)

4) Water pollution control (sanitary and storm water discharge requirements and conditions, spill prevention and control)

5) Industrial safety, including industrial hygiene and health physics and fire safety (e.g., training and awareness, monitoring systems, ventilation systems, equipment maintenance, emergency response, fire prevention, and fire protection)

6) Walkdowns of the area, including out-of-the-way and limited access areas.

Surveillances of QAP elements (scheduled and unscheduled) are conducted for specific project activities (e.g., process controls, preparation of deliverables, configuration and document control, and records management) used to determine compliance of the activities to program requirements.

3.6.3 Audits{tc \l3 "3.6.3 Audits}

Planned, periodic audits are performed to verify compliance with the quality program to determine the effectiveness of the program. The audits also verify that TWRS-P Facility health, safety, and environment program, plans, and procedures are in compliance with applicable regulatory or permit requirements. Documentation of programs and processes at the facility that affect quality are within the scope of the audits program.

3.6.4 Management Assessments{tc \l3 "3.6.4 Management Assessments}

Management assessments, as required by criterion (b)(3)(I) of 10 CFR 830.120, are conducted with the direct participation of the manager of the TWRS-P Project organization. Management assessments address the following:

1) The adequacy of those portions of the QAP for which they are responsible to ensure its effective implementation

2) Identification of barriers hindering the accomplishment of management objectives, documenting response actions, and implementing corrective actions

Management systems and processes included within the scope of a management assessment include, but are not limited to the following:

1) Effectiveness of project interfaces
2) Information from quality program performance indicators
3) Staff training and qualification effectiveness
4) Effectiveness of supervisory oversight and support
5) Evaluation of the adequacy of resources and personnel to achieve and ensure quality
6) Effectiveness of quality program requirements implementation.

3.6.5 Performance Monitoring{tc \l3 "3.6.5 Performance Monitoring}

Performance monitoring at the TWRS-P Facility verifies that activities are conducted in accordance with health, safety, and environment programs, plans, and procedures. Performance monitoring is conducted on an annual basis by a multi-disciplinary team consisting of environmental protection, industrial safety, process safety, health physics, and the nuclear safety and regulatory staff. Performance monitoring includes, but is not limited to, reviewing records, plans, and procedures; observing operations and other activities; and interviewing key personnel. Findings are provided in written reports with recommendations for improvements, as applicable.

Performance monitoring ensures that high standards of performance are maintained in at least the following areas:

1) TWRS-P Project site monitoring program
2) Health and safety program
3) Personnel training program
4) Hazardous material management and waste tracking systems
5) Conduct of operations and maintenance
6) Environmental program
7) Housekeeping.

3.6.6 Lessons Learned{tc \l3 "3.6.6 Lessons Learned}

The TWRS-P Project lessons learned program requires the evaluation of information obtained from the TWRS-P Project audits and assessments program. Information relating to deficiencies identified is evaluated for incorporation into TWRS-P Project training materials or for presentation to TWRS-P Project staff by other methods as appropriate (e.g., required reading). (For additional information, see Section 3.7.8, ALessons Learned.@)

3.6.7 Feedback and Trending{tc \l3 "3.6.7 Feedback and Trending}

As described above, deficiencies are used as a lessons learned to feed relevant information back to appropriate TWRS-P Project staff members to assist in precluding recurrence. Trending of the information obtained from the audits and assessment program within various performance areas is used to verify that continuous improvement is being achieved in the TWRS-P Project. If repeat deficiencies or recurring causes are indicated, prompt follow-up action is initiated to identify additional corrective action(s) needed to preclude further recurrence. These additional corrective actions are also tracked to completion and their adequacy is verified to ensure correction of the problem. The trends are also evaluated for the potential of a programmatic failure. Programmatic failures are reportable under 10 CFR 820.

3.7 INCIDENT INVESTIGATIONS{tc \l2 "3.7 INCIDENT INVESTIGATIONS}

Incident identification, reporting, and corrective action resolutions assist the TWRS-P Facility management in taking actions that prevent recurrence of identified problems. In addition, the TWRS-P Project incident identification and reporting process ensures that the TWRS-P Facility regulator and TWRS-P Facility management are informed of events and conditions (and their causes) that could adversely affect the health and safety of workers and the public, quality of work, security, environment, and operations.

(*The incident investigation and reporting process will be developed and implemented for TWRS-P Facility construction and preoperational testing activities in preparation for operation.)*

3.7.1 Organizational Responsibilities{tc \l3 "3.7.1 Organizational Responsibilities}

The TWRS-P Facility General Manager is responsible for developing and implementing the incident identification and reporting process. The General Manager is also responsible categorizing and reporting of events and conditions. However, the authority to perform specific actions may be delegated, at the discretion of the General Manager. The TWRS-P Facility staff is responsible for promptly notifying TWRS-P Facility management of events or conditions that could adversely affect the health and safety of the public and workers or the quality of work, security, environment, or operations. Incident identification and reporting involves the discovery (when line management is informed of a reportable event), categorization, notification, investigation, reporting, and processing of information related to emergency events and conditions, unusual incidents, and off-normal incidents associated with the TWRS-P Facility. Emergency events and conditions and unusual incidents are reported to the regulator. Offnormal incidents are reported to the regulator at the discretion of the General Manager. All reportable events or conditions are reported to the TWRS-P Project regulator and the DOE Headquarters Emergency Operations Center (HQ EOC). Some of these events or conditions are also reported to state, local, or other Federal agencies. The ES&H organization is responsible for investigating and evaluating the reportable incidents, preparing and submitting the reports, and trending investigation results and corrective actions.

Emergencies are the most serious incidents and require an increased alert status for onsite personnel and, in specified cases, for offsite personnel. Required actions are discussed in Chapter 9.0, AEmergency Management.@ An unusual incident is a non-emergency event or condition that exceeds the off-normal incident threshold criteria. Off-normal incidents are off-normal or unplanned events or conditions that adversely affect, or are indicative of degradation in the safety, safeguards, or security; environment or health protection; performance; or operation of the TWRS-P Facility. (See Section 3.7.3, ACategorization of Incidents.@)

3.7.2 Incident Identification and Reporting Process{tc \l3 "3.7.2 Incident Identification and Reporting Process}

This section presents a summary of the more significant aspects of the incident identification and reporting process. Additional details are presented in Sections 3.7.3 through 3.7.10.

1) The TWRS-P Project process provides the guidance to implement the requirements for the incident identification and reporting. *(The process includes discovering, categorizing, notifying, investigating, reporting, and processing of incidents and incident reports.)*

2) Designated TWRS-P Facility staff are trained on the TWRS-P Facility incident identification and reporting process requirements, implementing procedures, and applicable lessons learned from incidents at TWRS-P Facility and similar nuclear or chemical facilities. *(Designation of individuals and training requirements will be developed during Part B.)*

3) Events or conditions are categorized by individuals trained and qualified to make the determination. The categorization is made as soon as practicable after identification, but within 2 hours following discovery of the event or condition.

4) Immediately following discovery of a reportable event or condition, TWRS-P Facility management ensures that immediate responses are taken to stabilize or return the TWRS-P Facility to a safe condition promptly notifies the TWRS-P Facility General Manager (or designee) and appropriate line management and records appropriate information pertaining to the incident for the investigation process.

5) For an incident that indicates a potential inadequacy of previous safety analysis as defined in an approved safety analysis report or that indicates a possible reduction in safety margins as defined in the TSRs, actions are taken to place or maintain the facility in a safe state and a safety evaluation is performed. The completed safety evaluation is submitted to the regulator prior to removing any operational restrictions initiated in response to the incident.

6) The TWRS-P Facility regulator and HQ-EOC are informed as soon as practicable following discovery of a potential emergency event or condition. In all cases, this is within 15 minutes following an event or condition categorized as an emergency or within 2 hours after categorization of an event or condition as an unusual incident.

7) Appropriate emergency response personnel are notified. Emergency notifications of personnel are discussed in Chapter 9.0, AEmergency Management.@

8) A notification report is submitted, as soon as practical, but in all cases, before the close of the next business day from the time of the categorization (not to exceed 80 hours). This notification report is a hard copy or an electronic copy discussed in Section 3.7.7, AReporting and Processing Database.@

9) An update report is required if the event or condition is categorized as an emergency. The update report is submitted, as soon as practicable, but in all cases, before the close of the next working day from the time of recategorization of the event or condition (not to exceed 80 hours). The update report includes justification for the change in the category.

10) The final report is submitted, as soon as practical, but within 45 calendar days following the initial categorization of the incident. The final report includes identifies the root cause of the event or condition, determines and schedules corrective actions, and identifies lessons learned.

11) An evaluation is performed in a timely manner to determine if the incident represents a possible *Price-Anderson Amendments Act* PAAA nuclear safety requirement noncompliance in accordance with 10 CFR 820, AProcedural Rules for DOE Nuclear Activities.@ TWRS-P Facility management is informed of the results of the evaluation and appropriate actions initiated.

12) A tracking and trending evaluation is initiated, commensurate with a tailored approach, to identify any adverse trending results indicative of a potential programmatic failure.

13) Reporting requirements of various state and Federal agencies are contained in Section 3.7.4, AState and Federal Agency Notifications.@ *(Specific TWRS-P Project reporting requirements to state and Federal agencies will be identified in the TWRS-P Facility FSAR.)*

14) The incident reports are evaluated for inclusion in the lessons learned program.

15) Notification reports, update reports, final reports, investigation reports, and supporting documentation are maintained in accordance with Section 3.8, ARecords Management.@

3.7.3 Categorization of Incidents{tc \l3 "3.7.3 Categorization of Incidents}

If an event or condition is not categorized as an emergency, it is categorized as an unusual incident or an off-normal incident. Example of events or conditions considered to be unusual incidents or off-normal incidents at the TWRS-P Facility are presented in Table 3-3. If categorization is not clear or the incident exceeds the threshold of more than one criterion, the incident is categorized at the higher level considered. The selected category is subsequently changed to a higher or lower category as additional information is obtained or as the event progresses.

Table 3-3. Unusual and Off-normal Incident Examples (Sheet 62)

Groups of Categorized Incidents	Sub-Groups	Unusual Incidents	Off-normal Incidents
Facility Condition	Nuclear criticality safety	Violation of the double contingency criticality specifications such that no valid controls are available to prevent a criticality accident	Any nuclear criticality safety violation or infraction of procedures not covered by other reporting criteria
	Fires, unplanned chemical reactions, and explosions	Any fire, unplanned chemical reaction, or explosion damaging licensed material or damaging any device, container, or equipment containing licensed material	Any fire or explosion not required to be reported as an unusual incident that activates a fire suppression system or disrupts normal facility operations
	Any unplanned incident that results in the safety status or the licensing basis or process being seriously degraded	Any operation or condition prohibited by the Technical Safety Requirements (TSRs) Any event or condition that alone could prevent the prevention or mitigation of an accident	Discovery of a condition that leads TWRS-P Facility to limit facility operations, either self-imposed or because of the identification of a potential degradation of the licensing basis; this includes operation or condition prohibited by the Licensee Controlled Requirements (LCRs)
	Facility in a degraded or unanalyzed condition	Any event or condition during operation or shutdown that results in the facility being seriously degraded or being in an unanalyzed condition that significantly compromises safety of the public, or outside the design basis for the protection of the public	Any event or condition during operation that results in the facility being seriously degraded or being in an unanalyzed condition that significantly compromises safety of the workers, or outside the design basis for the protection of the worker.
	Spread of radioactive contamination or loss of control of radio-active material	Identification of radioactive contamination offsite in excess of 100 times the surface contamination levels specified in Table 5-3 that has not been previously identified and formally documented	In an uncontrolled area an unplanned spill of liquids (in excess of one gallon) contaminated with radioactive material in concentrations greater than ten times the values in 10 CFR 20, Appendix B, Table 2, Column 2
	A deficiency such that a structure, system or component (SSC) vital to safety or program	Failure or performance degradation of any Design Class I or II SSC that prevents satisfactory performance of the design function when it is	Failure or performance degradation of a Design Class I or II SSC when the equipment is not required to be operable or in

Table 3-3. Unusual and Off-normal Incident Examples (Sheet 62)

Groups of Categorized Incidents	Sub-Groups	Unusual Incidents	Off-normal Incidents
	performance does not conform to stated safety criteria and cannot perform its intended function	required to be operable or in operation and results in a significant performance degradation	operation, that could have resulted in a significant performance degradation of a facility or process
	Violation of procedures (including maintenance requirements and system lineups) or in-adequate procedures, either of which result in adverse effects on performance, safety, or reliability	Maintenance performed on Design Class I or II SSCs without meeting the required facility conditions for unavailability resulting in a significant performance degradation.	Incorrect maintenance on or unauthorized modifications to Design Class I or II SSC required to be operable or in operation.
	Operations	Actuation of Design Class I or II SSC or their alarms resulting from an actual unsafe condition. Inadvertent alarms are not required to be reported unless an actuation of a Design Class I or II SSC occurs and the actuation is considered significant as defined by the approved facility procedures. Actuation of continuous air monitoring systems identified as Design Class I or II equipment do not have to be reported if their actuation was found to be the result of radon-thorium effects on the system or their actuation is expected because of maintenance tasks and other planned operations in the facility where the potential for release of radioactivity is anticipated to occur and the facility workers and co-located workers are appropriately protected.	Spontaneous actuation of Design Class I or II SSC when no actual unsafe condition existed.
Environmental	Radionuclide releases	Release of a radioactive material that violates environmental requirements in state or Federal permits or regulations	Any release of radioactive material to controlled or uncontrolled areas that is not part of normal monitored release and

Table 3-3. Unusual and Off-normal Incident Examples (Sheet 62)

Groups of Categorized Incidents	Sub-Groups	Unusual Incidents	Off-normal Incidents
			exceeds 50% of a *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) reportable quantity specified for such material according to 40 CFR 302
	Release of hazardous substances, regulated pollutants or oil	Release of a hazardous substance or regulated pollutant that exceeds a CERCLA reportable quantity according to 40 CFR 302 and 40 CFR 355 for chemicals and extremely hazardous substances or exceeds a Federally permitted release by a reportable quantity	Release of a hazardous substance or regulated pollutant to controlled or uncontrolled areas that is not part of a normal, monitored release and exceeds 50% of a CERCLA reportable quantity as specified for such material according to 40 CFR 302
	Discovery of hazardous material contamination	Discovery of onsite or offsite contamination resulting from operations that does not represent an immediate threat to the public but exceeds a reportable quantity for such material according to 40 CFR 302	Discovery of onsite contamination due to operations that exceeds 50% of a reportable quantity for such material according to 40 CFR 302
	Ecological resources.	Any incident causing significant impact to any ecological resource for which the DOE is a trustee (i.e., destruction of a critical habitat, damage to a historic/archeological site, or damage to wetlands)	N/A
	Agreement and compliance activities.	Any incident under any agreement, or compliance area that requires notification of a regulatory agency (other than the TWRS-P Project regulator) within 4 hours or less, or triggers any outside regulatory agency action level	Any agreement, compliance, remediation or permit-mandated activity for which formal notification of enforcement has been received from the relevant regulatory agency that a site or facility is considered to be in noncompliance with a schedule or requirement (e.g., Notice of Violation, Notice of Deficiency, Notice of Intent to Sue, and other types of enforcement actions)

Table 3-3. Unusual and Off-normal Incident Examples (Sheet 62)

Groups of Categorized Incidents	Sub-Groups	Unusual Incidents	Off-normal Incidents
Personnel Safety	Occupational illness and injuries	Any incident because of TWRS-P Facility operations resulting in a fatality or terminal injury or illness	Any occupational illness or injury that results in-patient hospitalization
	Vehicular/ transpor-tation accident	Any vehicular incident resulting in fatalities or terminal injuries	Any vehicular incident with injury lies resulting in a lost workday
	Safety concerns	Design Class I or II SSC damage or personal injury due to the unapproved use of flammable, toxic, explosive, corrosive, or other unsafe or dangerous processes, chemicals, materials, or methods not in accordance with standard operating procedures or work plans	Unapproved use of flammable, toxic, explosive, corrosive, or other unsafe or dangerous processes, chemicals, materials, or methods not in accordance with standard operating procedures or work plans
Personnel radiation protection	Radiation exposure	Determination of a dose that exceeds the limits specified in Table 5-1 (for onsite) or 40 CFR 41.62 or 40 CFR 191.04 (for offsite exposures to a member of the public)	Any single occupational exposure that exceeds an expected exposure $100 mrem
	Personnel contamination	Any single incident resulting in the contamination of five or more personnel or clothing (excluding protective clothing) at a level exceeding the values in Table 5-3, the contamination level will be based on direct measurement and not averaged over 100 cm^2	Any measurement of personnel or clothing contamination (excluding protective clothing) at a level equal to or exceeding five times the values in Table 5-3, the contamination level will be based upon direct measurement and not averaged over 100 cm^2
	Injured personnel	Transportation of injured potentially contaminated individual offsite for treatment of injuries	N/A
Safeguards and Security	Criminal acts	Criminal acts at the TWRS-P Facility involving: 1) bomb-related incidents, includ-ing location of a suspicious device or a noncredible bomb threat 2) a noncredible terrorist threat 3) a noncredible sabotage threat	Onsite felony conspiracies (i.e., blackmail, fraud, embezzlement, extortion, and forgery) not involving classified information

Table 3-3. Unusual and Off-normal Incident Examples (Sheet 62)

Groups of Categorized Incidents	Sub-Groups	Unusual Incidents	Off-normal Incidents
	Substance abuse	Discovery of the prohibited use, possession or involvement of illegal drugs or alcohol by personnel that may affect the operation of Design Class I or II SSCs	Discovery of the prohibited use, possession or involvement of illegal drugs or alcohol by personnel that may affect TWRS-P Facility operations, including detection of personnel not fit for duty attributable to the use of alcohol or illegal drugs
	Demonstrations or protests	Disruptive activities impeding vehicular or employees' access or egress.	Lawful activities warranting deployment of additional protective measures
	Firearms	Unauthorized firearms discharge resulting in personnel injury	Unauthorized firearms discharge resulting in no personnel injury
	Other security concerns	Unauthorized use, possession, alteration, or theft of a security badge, credentials, shield, or other form of official identification (to include blank badge stock/forms) to gain access to the facility	Onsite death of personnel by unnatural causes (e.g., suicide, drug overdose)
Transportation	Transportation of hazardous materials	Any packaging or transportation activity (including loading, unloading, or temporary storage) involving the offsite release of radioactive material, etiologic agents, a reportable quantity of hazardous substance, or marine pollutants	Any packaging or transportation activity involving: 1) the offsite release of nonradioactive hazardous material or any quantity of hazardous waste 2) the onsite release of radio-active materials, etiologic agents, hazardous sub-stances, hazardous waste, or marine pollutants
Value Basis Reporting	Defective item, material, or service	Failure of a Design Class I or II SSC attributed to use of defective or counterfeit components	Discovery of any actual or potential defective item, material, or service in any application whose failure could result in a substantial safety hazard. Examples include the identifica-tion of counterfeit components found in 1) cranes and elevators - items used in the load bearing path of the crane or elevator 2) nuclear applications such as:

Table 3-3. Unusual and Off-normal Incident Examples (Sheet 62)

Groups of Categorized Incidents	Sub-Groups	Unusual Incidents	Off-normal Incidents
			- valves or components used to contain radioactive fluids or high pressure steam or fluids - refurbished molded case circuit breakers supporting Design Class I or II SSCs
Facility Status	Any unplanned event or condition that re-sults in shutting down the facility, significantly curtailing operations	The initiation or completion of a shutdown of the facility required by a TSR	The initiation or completion of a shutdown of the facility required by an LCR
Cross-Category Items	A series of related incidents when taken individually do not warrant reporting under preceding criteria but when taken collectively are considered significant enough to warrant reporting	Events determined by the TWRS-P Facility General Manager	Events determined by the TWRS-P Facility General Manager

3.7.4 State and Federal Agency Notifications{tc \l3 "3.7.4 State and Federal Agency Notifications}

Notifications to state or Federal agencies of incidents affecting state or Federal permits or regulations are made in accordance with the requirements contained in the TWRS-P Facility Environmental Report (BNFL 1997c) or applicable permitting documents. However, in some cases, an incident report to the TWRS-P Facility regulator and HQ-EOC may also be required in addition to the state or Federal agency reporting requirements. Examples include releases that exceed the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) reportable quantity; the *Emergency Planning and Community Right-to-Know Act* (EPCRA) reportable quantity; Washington State Department of Ecology (Ecology) hazardous substance limits; or environmental permit limits.

3.7.5 Incident Investigation Process{tc \l3 "3.7.5 Incident Investigation Process}

An incident investigation team is established for incidents that have the potential to result in a major accident or a release of hazardous or radioactive material from the controlled area. The team consists of at least one person knowledgeable in the process involved, including a subcontract employee if the incident involved work of the subcontractor, and other persons with appropriate knowledge and experience to thoroughly investigate and analyze the incident. A report is prepared at the conclusion of the investigation. The report is reviewed with all affected personnel whose job tasks are relevant to the incident findings. The incident report includes as a minimum:

1) Date of incident
2) Date investigation began
3) A description of the incident
4) The factors that contributed to the incident
5) Any recommendations resulting from the investigation.

A system is established to promptly address, resolve, and document the incident report findings and recommendations.

The incident categorization is one factor used in determining the extent of the incident investigation in terms of the size of the investigation team, its independence, and the depth of the root cause analysis. By this process, the extent of the incident investigation is tailored to the consequences of the event or the potential consequences of a Anear miss.@ For example, by tieing the incident investigation to the event categorization, an increasing level of investigation is applied to the following events; 1) a hazardous substance release that exceeds 50% of a CERCLA reportable quantity, 2) a chemical release that violates environmental requirements in state or federal permits, and 3) a chemical release that had reported affects on co-located workers.

The categorization process is not the only factor that determines the extent of incident investigation. For example, incidents that are repeat occurrences will receive more in-depth investigation, in part, to determine the reason for ineffectiveness of the corrective actions. Where repeat incidents or recurring causes are indicated, prompt follow-up action is initiated to identify additional corrective actions needed to preclude recurrence. These additional corrective actions are tracked to completion and their adequacy verified to ensure correction of the problem. An evaluation is also conducted for repeat occurrences to determine if the trend represents a programmatic failure reportable under 10 CFR 820.

The investigative process is used to gain an understanding of the incident, its causes, and corrective actions necessary to prevent recurrence. The steps used in the incident investigation process are summarized below.

1) The scope and depth of analysis of a particular incident is tailored to the significance of the incident.

2) If the investigative process warrants a team investigation as determined from the evaluation above, at least one member of the investigative team is assigned from the organization most closely involved with the activities that were ongoing at the time of the event or incident. This

member provides detailed firsthand knowledge of the performance of the activities. Other members are independent, and all members are knowledgeable of facility design and operations, or are experts in safety (industrial or process). There is no retribution for participating on the team.

3) At least one member is formally trained in at least one of the various industry-accepted methods of incident investigation and cause determination.

4) The team investigates the event, identifies underlying causes, formulates corrective action recommendations, and documents the results of the investigation.

5) The incident investigation process, its implementation, and its effectiveness are reviewed periodically by the TWRS-P Project Safety Committee (see Section 2.2, ASafety Committees@) or by audits or assessments (see Section 3.6, AAudits and Assessments@).

3.7.6 Reporting and Processing System Database{tc \l3 "3.7.6 Reporting and Processing System Database}

The centralized DOE electronic database (Occurrence Reporting and Processing System [ORPS]) for notification reports update reports and final reports is used to document and distribute the information regarding the investigation of reportable events or conditions. The ORPS database is updated to reflect the current status of corrective actions identified in the final report.

3.7.7 Corrective Action Determination{tc \l3 "3.7.7 Corrective Action Determination}

Causes of incidents (including root, direct, and contributing causes) are classified into several broad categories and various subcategories *(to be identified during Part B)*. The causes of the incidents are trended and evaluated to determine if the problem is programmatic. *(The process will be developed during Part B.)*

3.7.8 Lessons Learned{tc \l3 "3.7.8 Lessons Learned}

The TWRS-P Project lessons learned program evaluates TWRS-P Facility incidents and also evaluates lessons learned, events, deficiencies, and similar information from other DOE sites, the commercial nuclear power industry, and relevant events in other technical domains. The sources of lessons learned occurrences and conditions include, but are not limited to, NRC documents, Hanford, Savannah River, and Sellafield Sites internal lessons learned, Occupational Safety and Health Administration (OSHA) safety bulletins, operational readiness review (ORR) final reports, and DOE operating experience weekly summaries.

The TWRS-P Facility (*position title to be determined in Part B)* coordinates the distribution of lessons learned to the appropriate organizations or individuals within the facility. Information relating to incidents is then evaluated and fed back to the training organization for incorporation into TWRS-P Facility training materials or for presentation to TWRS-P Project staff by other methods as appropriate (required reading for example). If applicable, safety and hazards analyses are reviewed and revised, procedures are modified, maintenance practices are changed, and TSRs, ISARs or FSARs, or LCRs are revised to incorporate lessons learned that should avoid a recurrence of an adverse work practice or operating experience and lead to improved operations.

3.7.9 Feedback and Trending{tc \l3 "3.7.9 Feedback and Trending}

As described above, incidents are used as a lessons learned to feed back relevant information to appropriate TWRS-P Facility staff members to assist in precluding recurrence.

Trending of incident information, within various performance areas, is also used to determine if continuous improvement is being achieved in the TWRS-P Project. If repeat incidents or recurring causes are indicated, prompt follow-up action is initiated to identify additional corrective actions needed to preclude recurrence. These additional corrective actions are tracked to completion and their adequacy is verified to ensure the correction of the problem.

An evaluation is also conducted to determine if the trend represents a programmatic failure reportable under 10 CFR 820 (see Section 3.7.2 AIncident Identification and Reporting Process@).

3.8 RECORDS MANAGEMENT{tc \l2 "3.8 RECORDS MANAGEMENT}

The policy for the TWRS-P Project records management system is presented in BNFL-5193-QAP-01, *Tank Waste Remediation System Privatization Project Quality Assurance Program* (BNFL 1997a). The QAP, Section 4.0, ADocuments and Records,@ provides the responsibilities and requirements to control documents and records of quality affecting activities.

The QAP defines the terms document and records. A document is recorded information that describes, specifies, reports, certifies, requires, or provides data or results. Documents are prepared, reviewed, approved, issued, and revised to prescribe processes, specify requirements and establish design. The TWRS-P Project records are completed documents or other media that provide objective evidence of the quality of an item, service, or process. The records management system established for the TWRS-P Project is consistent with the schedule for accomplishing work activities. Records are specified, prepared, reviewed, approved, stored, and maintained in accordance with approved TWRS-P Project implementing procedures and instructions (*to be developed during Part B*). Measures are established to ensure that records are legible, identifiable, retrievable, and protected against damage, deterioration, or loss. The records management system controls are not applicable to documents of work in progress until they are completed (i.e., when the documents become records).

3.8.1 Organization and Administration{tc \l3 "3.8.1 Organization and Administration}

(Records management specialists, and other key personnel having responsibility for managing TWRS-P Project records will be identified. Their responsibilities, qualifications, and training will be described in the PSAR for implementation of QA records related to activities important to safety and protection of the environment.)

(Organizational responsibilities to ensure that activities affecting the quality of Design Class I and II activities are prescribed by documented instructions, procedures, and drawings, and accomplished through implementation of these documents will be described in the PSAR.)

The TWRS-P Project QA Manager is responsible for verifying that the records management system meets the applicable requirements. This verification by the QA organization is conducted assessments and audits program. The assessments by the QA organization also evaluate the effectiveness of the records management system. (Section 3.3, AQuality Assurance,@ and Section 3.6, AAudits and Assessments,@ present additional details of these audit and assessment activities.)

3.8.2 Types of Records{tc \l3 "3.8.2 Types of Records}

Design specifications, design documents, procurement documents, procedures, and other controlled documents specify QA records that need to be generated, supplied, and maintained. For example, controlled design documents specify the design records to be generated, supplied, or maintained as a result of activities prescribed in those documents.

QA records furnish evidence of the quality of items or activities affecting quality for the TWRS-P Project in the design, construction, operation, and deactivation of the TWRS-P Facility. Records include design records; records of use; results of reviews, inspections, tests, surveillances, audits, and assessments reports; monitoring of work performance; materials analyses; and other similar documentation. The records also contain data such as qualifications of personnel and equipment. Similarly, inspection and test records identify the inspector or data recorder, type of observation, date and results, evidence as to acceptability of results, and action taken for any noted deficiencies.

Table 3-4 provides examples of records that are maintained by the records management system. *(This guidance will become more specific as the project moves from design and construction to the operations phase.)*

Table 3-4. Safety Management Records (Sheet 72)

Subject	Records
Licensing basis	C Integrated Safety Management Plan C Safety Requirements Document C Radiation Exposure Standard for Workers Under Accident Conditions C Preliminary Safety Analysis Report C Final Safety Analysis Report C Technical Safety Requirements C Licensee Controlled Requirements C Quality Assurance Plan and Implementation Plan C Radiation Protection Program C Emergency Plan C Safety Evaluation Reports C Written communication with the regulator C Safety analyses C Environmental Radiation Protection Program
Design	C Major plant item list C Software verification and validation C Equipment and system testing requirements C Equipment qualification requirements C Facility and equipment description and drawings C Design criteria and basis for Design Class I and II structures, systems, and components (SSC) C Records of facility changes and associated integrated safety analyses C Specifications for Design Class I and II SSCs
Construction	C Records of site characterization measurements and data C Construction procedures C Inspection and test records C Construction material certifications C Calibration and test records C Nonconforming condition reports and closure records C Procurement specifications C Craft qualification records C Environmental monitoring data
Management Organization and Administration	C Procedures with safety implications C Performance plans C Employee concerns program, discipline, and employee action records (for protected activities) C Evidence of deliberate misconduct C Organization charts, position statements, training, and qualification records C Safety and health compliance records, medical records, and personnel exposure records

Table 3-4. Safety Management Records (Sheet 72)

Subject	Records
	C Safety statistics and trends C Incident reports
Operations	C Startup test results C Operating logs C Maintenance records C Calibration and testing data C Material balance, inventory, transfer, and disposal records C Material storage records C Facility operating procedures C Change control records for Design Class I and II procedures C Operator aids (e.g., charts and drawings used to assist operator in performing job) C Training records C Special test records C Corrective action determination and closeout reports C Unreviewed safety question screening and evaluation reports C Records pertaining to disposal of radioactive and mixed wastes
Integrated Safety Analysis	C Integrated Safety Analyses and supporting data, analyses, calculations, and documents C Change control records for Design Class I and II changes to facility C List of Design Class I and II SSCs C Methodology for setting acceptable safety limits and controls (including nuclear criticality safety) C Fire hazard analysis C Initial Safety Analysis Report C Hazard Analysis Report C Process Hazards Analysis
Radiation Safety	C Radiation protection (and contamination control) records C Radiation work permits C Radiation protection training records C Records pertaining to radiological process incidents, unusual incidents, and accidents
Nuclear Criticality Safety	C Nuclear criticality control procedures and statistics* C Records pertaining to nuclear criticality incidents, unusual incidents, and accidents* C Records pertaining to nuclear criticality safety analyses
Chemical Safety	C Chemical process safety procedures C Records pertaining to chemical process inspections, audits, investigations, and assessments C Records pertaining to chemical process incidents, unusual incidents, and accidents C Chemical process safety reports and analyses

Table 3-4. Safety Management Records (Sheet 72)

Subject	Records
	C Chemical process safety training
Fire Safety	C Hot-work permits and fire-watch records C Records pertaining to inspection, maintenance, and testing of fire protection equipment C Records pertaining to fire protection training C Prefire emergency plans
Emergency Management	C Review of emergency plan from outside emergency response organizations and supporting entities C Memoranda of understanding with outside emergency response organizations C Records pertaining to the training of personnel involved in emergency preparedness functions C Emergency drill and exercise records C Records pertaining to inspection and maintenance of emergency response equipment and supplies
Environmental Protection	C Environmental release and monitoring records C Environmental Report C Environmental Permits (e.g., air, water, and waste) C Environmental Impact Statement and Record of Decision C Environmental monitoring data
Occupational Safety and Health	C Material Safety Data Sheets C Training records of staff and contract employees C Inspection and testing reports C Equipment deficiency reports and resolution
Deactivation and Decommissioning	C Deactivation records C Incident reports to support decommissioning (e.g., radiological and chemical spills)
Quality Assurance	C Training and qualification/certification records C Audit and assessment procedures and reports C Nondestructive testing procedures, calibration data, and test results C Calibration results C Nonconforming condition reports and closure documentation C Procurement documentation C Supplier assessments and vendor inspections C Project review of vendor drawings C Certified vendor information C Reports of suspect, fraudulent, or counterfeit materials or services

* Criticality analysis may show these records to be unnecessary.

3.8.3 Records Handling Procedures{tc \l3 "3.8.3 Records Handling Procedures}

Project Administration and Controls has the responsibility and authority for records management system activities including the following tasks:

1) Identifying records to be retained and time of retention
2) Identifying approvals required for disposal of records
3) Identifying records requiring controlled access and controls to be provided
4) Protecting records from loss, tampering, or theft, and during an emergency
5) Maintaining the records management system.

A Records Inventory and Disposition Schedule (RIDS) system is implemented to file project records. Procedures (*..to be developed in Part B.*.) describe records management processes for the validation; indexing, identification, and retrieval; distribution; classification; retention; correction; receipt; and readability and useability. Summaries of record-handling procedures for the TWRS-P Project are provided in the following sections.

3.8.3.1 Validation{tc \l4 "3.8.3.1 Validation}. Documents are valid records when stamped, initialed, or signed and dated by authorized personnel or otherwise authenticated. Authentication, or validation, involves reviewing the document to ensure that the information appearing in the document is accurate and complete and that no additional entries are made unless subjected to a formal change control process. These records may be originals or legible reproductions.

3.8.3.2 Indexing, Identification, and Retrieval{tc \l4 "3.8.3.2 Indexing, Identification, and Retrieval}. Records are indexed in the RIDS that include record retention time and location of the record within the records management system. The records indexing system provides sufficient information to associate the record with the item or activity to which it applies. This information ensures that an item or activity has a complete file and facilitates retrieval of a record. Record retrieval is controlled by procedure (*to be developed during Part B)* for activities such as handling and control provisions for various kinds and sets of record, and the types of recording media that compose the materials accounted for in the records management system.

3.8.3.3 Distribution{tc \l4 "3.8.3.3 Distribution}. The distribution, handling, and control appropriate for each type of record is performed in accordance with approved procedures (*to be developed during Part B)*. Standard distribution lists are augmented by the addition of specific personnel or organizations affected by the record.

3.8.3.4 Classification and Retention{tc \l4 "3.8.3.4 Classification and Retention}. Records are classified and retained as lifetime or nonpermanent in accordance with the criteria provided below. The classification is also commensurate with the importance to safety of the specific record.

1) Records classified and retained as lifetime records meet one or more of the following criteria:

    a) Those which would be of significant value in demonstrating capability for safe operation, deactivation, and decommissioning

    b) Those which would be of significant value in maintaining, reworking, repairing, replacing, or modifying the facility

c) Those which would be of significant value in determining the cause of an accident or malfunction of an item

d) Those which provide required information for in-service inspections

e) Those which substantiate development or decisions involving safety, health, and the environment

f) Those which provide evidence of conformance to codes, standards, specification(s), regulations, and other mandatory requirements.

2) Nonpermanent records are those required to show evidence that an activity was performed in accordance with the applicable requirements but need not be retained for the life of the item because the records do not meet the above criteria for lifetime records. Disposition of nonpermanent records is in accordance with applicable regulations, contract requirements, and organizational policies and procedures.

3.8.3.5 Corrections{tc \l4 "3.8.3.5 Corrections}. Records are corrected in accordance with procedures (*to be developed during Part B)* that provide for appropriate review or approval by the originating organization. The correction includes the date and identification of the person authorized to make such corrections, with a single line drawn through the deleted text.

3.8.3.6 Record Receipt{tc \l4 "3.8.3.6 Record Receipt}. Records Management, *(..Records management specialists, and other key personnel having responsibility for managing TWRS-P Project records, will be identified and their responsibilities, qualifications, and training described in the PSAR for implementation of QA records related to activities important to safety and protection of the environment...)* responsible for receiving the records, provides protection from damage or loss during the time records are in their possession. Project Administration and Controls is responsible for organizing and implementing a system for record receipt control for permanent and temporary storage to ensure adequate permanent and temporary storage. The TWRS-P Facility record processing center uses one-hour, fire-rated, Underwriters Laboratory-approved containers for storage of records following receipt.

The RIDS, which is the record receipt control system, includes the following:

1) A method for designating the required records

2) A method for identifying the records received

3) Procedures for receiving and inspecting incoming records

4) A method for submitting completed records to the storage facility without unnecessary delay.

The control system permits a current and accurate assessment of the status of records during the receiving process.

3.8.3.7 Readability and Useability{tc \l4 "3.8.3.7 Readability and Useability}. Readability and useability of the records, including computer codes and computerized data, are protected and maintained while in storage.

3.8.4 Record Storage and Protection{tc \l3 "3.8.4 Record Storage and Protection}

Records are stored in a predetermined locations that meet the requirements of applicable standards, codes, and regulatory agencies.

(The PSAR will describe the location(s) and physical characteristics of the records storage areas to ensure protection and preservation in legible, identifiable, retrievable, usable form, including protection of the stored records from loss, theft, tampering, unauthorized access, damage, or deterioration in normal times and during and after emergencies for their designated lifetimes.)

3.8.4.1 Storage{tc \l4 "3.8.4.1 Storage}. Records storage includes the following requirements:

1) A description of the storage facilities including the types of repositories used (i.e., single, alternate, temporary, or dual) and the requirements met

2) The filing system used

3) A method for verifying that the received records are in agreement with the transmittal document, and that the records are legible and reproducible

4) A method for verifying the records are those designated and are traceable to the item or activity to which the record applies

5) The rules governing access to and control of the files

6) A method for maintaining control of, and accountability for, records removed from the storage facility

7) A method for filing supplemental information and disposing of superseded records

8) Storage methods to provide retrieval of information in accordance with planned retrieval times based on record type

9) A method for replacing, restoring, or substituting lost or damaged records.

3.8.4.2 Protection{tc \l4 "3.8.4.2 Protection}. To facilitate preservation of records in storage:

1) Features in the storage arrangement prevent damage from moisture or temperature.

2) Records are placed in holders and stored in metal file cabinets, protective containers, or on shelving.

3) Special processed records (e.g., radiographs, photographs, negatives, microfilm, and magnetic media) are preserved to prevent damage from excessive light, stacking, electromagnetic fields, temperature, or humidity.

Records are stored in facilities maintained in a manner that minimizes the risk of damage or destruction from:

1) Natural disasters such as winds (and associated missiles), floods, or fires
2) Environmental conditions such as high and low temperatures and humidity
3) Infestation of insects, mold, or rodents
4) Larceny and vandalism.

3.8.5 Records Maintained by Suppliers{tc \l3 "3.8.5 Records Maintained by Suppliers}

Each supplier is responsible for implementing portions of the records management system as it applies to the supplier=s scope of work. Specific responsibilities for identifying, preparing, validating, authenticating, logging, indexing, reviewing, classifying, correcting, safekeeping, storing, protecting, transmitting, distributing, retaining, dispositioning, and tracking when not in storage are described in procedures *(to be developed during Part B)*. The TWRS-P Project coordinates activities between organizations to ensure consistent processing of records.

Records maintained by a supplier, at the supplier's facility or other location(s), are accessible to TWRS-P Project personnel. Records accumulated at various locations before transfer are made accessible to the project directly or through the procuring organization.

Suppliers' nonpermanent records will only be disposed of after the following conditions are satisfied, as applicable :

1) Approval requirements for items released for shipment
2) Regulatory requirements
3) Operational status permits
4) Warranty considerations
5) Purchase requirements.

The QA records are generated by suppliers to TWRS-P Facility. Each supplier prepares, validates, authenticates, and corrects their record, and records from their suppliers, if any. Such records are transmitted to TWRS-P Facility through a formal transmittal by the responsible supplier representative.

The TWRS-P Project is responsible for performing final identification, logging, indexing, reviewing, classifying, safekeeping, storing, protecting, transmitting, distributing, retaining, conducting retrieval maintenance, and tracking of required supplier records.

3.9 PROCEDURES{tc \l2 "3.9 PROCEDURES}

All TWRS-P Project activities that affect safety are carried out in accordance with formally documented manuals, procedures, or instructions. The role of this system of documents is to provide a formal unequivocal means of communications within and between organizational groups. These documents accomplish the following functions:

1) Promulgate regulatory requirements and high-level policy to operational and service organizations

2) Direct how functional area activities should be conducted to achieve safety

3) Direct how to consistently and predictably operate and maintain the facility, systems, and equipment effectively and safely

4) Direct how to respond to process abnormalities and other emergency conditions

5) Transfer short-term information between groups at the working level.

3.9.1 General Information{tc \l3 "3.9.1 General Information}

The TWRS-P Facility document system addresses safety, quality, and environmental activities during the operational phase of the project. The document system used during facility startup is described in Section 3.10,@ Initial Testing and Preoperational Safety Review.@ The facility document system comprises a facility manual, facility procedures, and facility instructions.

3.9.1.1 Facility Manual{tc \l4 "3.9.1.1 Facility Manual}. This manual provides an overview of the document system, its contents, and its maintenance.

3.9.1.2 Facility Procedures{tc \l4 "3.9.1.2 Facility Procedures}. The TWRS-P Facility procedures describe the management processes that are established to carry out the BNFL policies for operation, maintenance, modification, and supporting activities. The procedures provide facility workers with an acceptable, consistent, and systematic approach to the management of work. These procedures identify personnel with specific responsibilities and describe the actions to be taken.

The facility procedures are detailed in several functional areas, which include a number of subsections containing department procedures and supporting instructions that provide details for the undertaking of specific tasks. The facility procedure areas include titles such as:

1) Safety
2) Document Control
3) Interface Control
4) Purchasing and Material Control
5) Management Review and Audit
6) Process Control
7) Responsibilities, Training, and Communications
8) Financial Control
9) Design Control and Project Management
10) Environmental.

3.9.1.3 Facility Instructions{tc \l4 "3.9.1.3 Facility Instructions}. The TWRS-P Facility instructions are produced in support of the facility procedures. Instructions provide a step-by-step guide for the tasks to be completed, and identify the personnel responsible and the record retention requirements. There are several classifications of facility instructions including operator instructions, maintenance instructions, quality plans, emergency instructions, and methods statements. Each of these classifications is described below.

1) Operating Instructions - Operating instructions provide instructions for operating facility equipment routinely and safely. Each operating instruction deals with a convenient set of related operations which can be linked together under a general broad title.

2) Maintenance Instructions - Maintenance instructions provide information for maintaining the facility and equipment safely in accordance with the maintenance schedule. The level of maintenance instruction provided takes into account the basic skills and training required for the involved maintenance personnel. The instruction concentrates on the detailed safety and technical information needed to safely and effectively accomplish the given task.

3) Quality Plans - Quality plans form an essential part of the Integrated Management System and are used, where appropriate, to document the management of multidisciplined activities including the control of interfaces, decision or hold points, and complex evolutions.

4) Emergency Instructions - Emergency instructions provide detailed, step-by-step instructions on the actions to be taken in response to off-normal conditions occurring at the facility. Instructions are provided in a style that provides a full and clear statement of the sequence of operations that must be carried out after the symptoms of a facility emergency have been identified. Emergency Instructions include, as applicable, checklists to highlight key steps to the facility operators and to allow them to record the completion of these steps.

5) Methods Statements - A methods statement is a document prepared in support of a one-time activity such as a facility modification, repair, or recovery from an off-normal condition. Method statements provide effective control of activities that are complex or potentially hazardous.

3.9.2 Procedure Preparation and Approval{tc \l3 "3.9.2 Procedure Preparation and Approval}

Facility procedures and instructions are developed and implemented with a level of rigor commensurate with their safety importance. Factors that determine a procedure's level of safety importance include the support provided for maintaining compliance with the TSRs and LCRs, or the discussion of activities involving credited defense-in-depth features. Procedures with higher levels of safety importance are subject to increased rigor with respect to their development, review, implementation, and change. Increased rigor includes independent review and endorsement by suitably qualified and experienced personnel or safety committees.

A structured process for the development of technical procedures is used at the TWRS-P Facility. This development process is described in the document control section of the facility procedures and includes all steps, from identifying the need for a procedure to gathering technical information, to approving and maintaining of the procedure. This process contributes to safe operations by effectively and consistently communicating requirements and techniques for safe performance of tasks and lessons learned.

Responsibility for developing accurate technical procedures and instructions within a functional area is assigned to the TWRS-P Project manager with responsibility for that area. TWRS-P Project personnel familiar with a process activity prepare technical procedures in accordance with the procedure preparation process. These authors ensure that the technical, safety, and human factors requirements and limitations for each Design Class I and II SSC, as delineated in the configuration management relational database, are accurately incorporated in the applicable procedure(s). The database provides the author with applicable information, such as, system descriptions, vendor equipment descriptions, FSAR sections, and testing results. The procedure development process envisions participation by operations, maintenance, and radiation protection, and engineering personnel in both the procedure preparation and review processes. Most procedures are developed prior to the initial startup phase and serve to discipline the design of tests to confirm facility operation to the design intent. During this phase, procedures are tested to demonstrate that they provide adequate direction for safe performance of facility activities.

The TWRS-P Project procedure development instructions specify the following elements for technical procedures:

1) Classification of procedure, both general subject and importance to safety

2) Purpose of the activity

3) Hazards and safety considerations including precautions, personnel protection measures, and control measures for off-normal conditions

4) Time frame for which the procedure is valid

5) Policies, restrictions, and operating limits governing the activity

6) Actions required for normal operations, startup, off normal operations, and shutdown

7) Actions required in case of off-normal conditions, temporary operations, emergency operations, and recovery after an emergency operation

8) Rules for entering and leaving the procedure.

The review process for procedures with higher levels of safety importance includes procedure verification and validation steps. During the verification portion of the review process, the procedure is evaluated for technical accuracy, proper format, and applicable human factors elements. A technical review by a knowledgeable individual compares the content of the procedure with the technical basis. Those aspects of the procedure that can affect safety during normal, off-normal, and emergency operations are addressed during verification. During the validation portion of the review process, the procedure is evaluated for correctness, compatibility with systems and equipment, human factors considerations, and usability. The goal of validation is to ensure that the procedure can be effectively used by assigned personnel during normal, off-normal, or emergency conditions.

3.9.3 Procedure Control Process{tc \l3 "3.9.3 Procedure Control Process}

To ensure that personnel use the most current procedures, the TWRS-P Facility implements processes that provide timely review, approval, revision, and control of procedures. All procedures that affect safety (both administrative control procedures and technical procedures) are periodically reviewed to ensure that they reflect management expectations, current configuration, and current practices. A structured process for making procedure changes between review cycles is implemented to incorporate improvements to procedures and to address changes identified through the configuration management process described in Section 3.1, AConfiguration Management.@

Procedures are controlled according to a structured process. Procedures are assigned a document number, and their review and approval activities are tracked and documented. A master copy is maintained and controlled copies are made available both as electronic and as hard copies.

3.10 TESTING PROGRAM AND PREOPERATIONAL SAFETY REVIEW{tc \l2 "3.10 TESTING PROGRAM AND PREOPERATIONAL SAFETY REVIEW}

This section describes the essential features of the TWRS-P Facility testing program and the preoperational safety review program. The testing program ensures that at the time of initial operation, the Design Class I and II SSCs and other significant facility equipment function as designed. The preoperational safety review validates that the hardware, programs, and personnel are in place and capable of supporting safe startup of the facility. A well-defined program with a commitment to testing and assessment is an integral part of the overall safety assurance philosophy at the TWRS-P Facility.

3.10.1 Testing Program Description{tc \l3 "3.10.1 Testing Program Description}

The testing program verifies that equipment and facilities are properly built, are in accordance with design intent, and meet appropriate safety criteria. In addition, the testing program documents the as-built condition and the initial operating parameters for the facility. *(A systematic analysis will be used to identify and define major testing of all SSCs to ensure compliance with design safety specifications and acceptance criteria. The testing identified by this analysis and required for Design Class I and II SSCs will be described in the PSAR.)*

The BNFL testing philosophy is consistent with best industry practice. It been refined through the construction and startup of many new and complex facilities over the last 20 years. The three phases of the testing program are supplier testing, construction testing, and startup testing. The supplier testing phase consists of component and system testing performed offsite by vendors under the direction of the architect engineer. The construction testing phase consists of installed component and system testing under the direction of the test organization reporting to the Construction Manager. The startup testing phase consists of integrated facility testing initially using waste simulants and finally using radioactive wastes. Startup testing is conducted by the operations startup organization reporting to the Facility Manager.

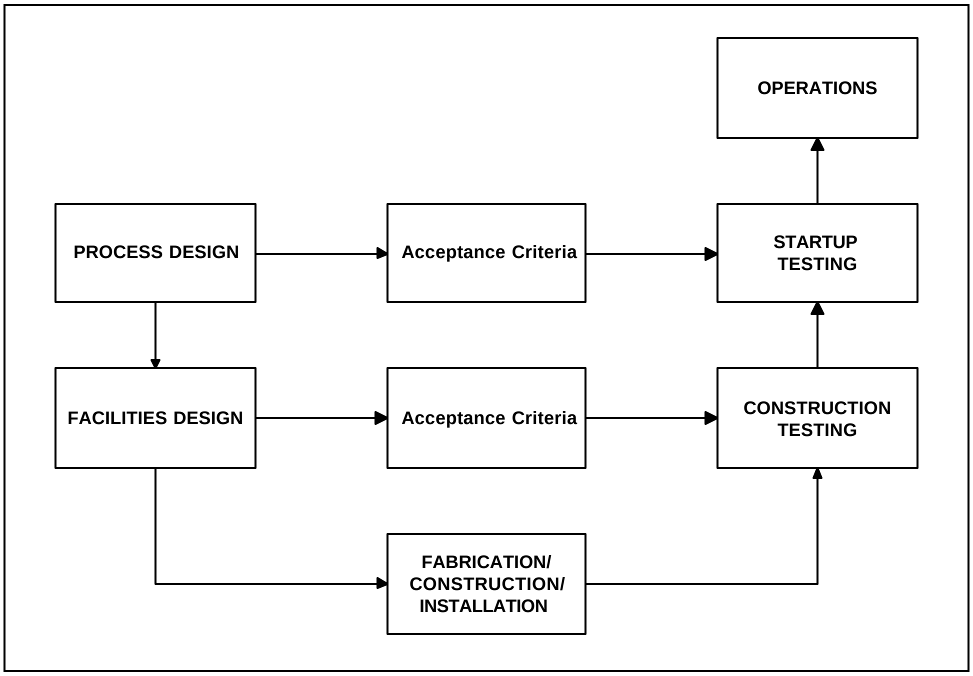
The BNFL approach to testing is directly related to the preceding design activities, with the objective of demonstrating facility functionality and safety. The TWRS-P Facility performs the function of generating vitrified glass products from Hanford Site tank farm waste. The process developed to produce this product is recorded on process flowsheets and process flow diagrams. These process documents in turn form the basis for the design activities of the facility designers (i.e., mechanical, ventilation, civil, structural, nuclear, electrical, instrumentation and control), whose responsibilities are to design the systems that facilitate the implementation of the production processes. The design of the facility systems leads to procurement activities, including site construction and offsite fabrication and manufacturing. Consequently, the testing is developed using the systems functions and system boundaries identified during design.

Fault detection, sooner rather than later, is the philosophy used to ensure cost-effective design, manufacture, fabrication, and construction. To accomplish this testing progresses through component, subsystem, and system levels, beginning at the component level. Only components that comply with procurement specifications established by the architect engineer are integrated into their respective system. Manufactured systems and components are typically tested at their point of fabrication and remain at that location until proven acceptable for delivery to the construction site.

The installed SSCs are subject to construction testing to ensure that they perform as they did at their point of manufacture and have been properly installed. These tests include energizing equipment, and checking mechanical operation, instrument calibration, electrical cable continuity, and pipe structural integrity.

System functional testing includes testing interfaces with supporting or supported systems, again using the acceptance criteria derived from the system design functional specifications. Interface testing is of prime importance to the success of testing in this phased manner because the consequences of failure affects the overall schedule. System integration only occurs when each side of an interface has been adequately tested to give confidence that integrated operation will succeed.

Upon satisfactory completion of system construction testing, startup testing is initiated. The basis for startup testing is that all systems are available and proven to be functional. In this way, startup testing becomes not a test of the systems that implement the process, but a test of the process itself through the operation of the implementing systems. The acceptance criteria for startup tests are derived directly from process design information. During testing, diagnostic data are collected and the initial operating parameters recorded. Operating points are adjusted to conform to the design basis of the system or component. Deficiencies detected in testing are tracked to ensure their resolution. Figure 3-2 illustrates the relationship between design functions, acceptance criteria, and testing phases.



For both system construction and startup testing, failure to meet applicable acceptance criteria is typically attributable to some element of the design process. Failures identified during construction testing are resolved by design and construction modifications, as appropriate. The modified system is retested against its compliance criteria, or an appropriate subset, to prove the success of the modification. Startup test failures are dealt with similarly, except that the process design is also analyzed to determine if systems must be modified to implement changes in process conditions.

The involvement of operations personnel throughout the design process and the involvement of design engineering personnel through the beginning of operations are key elements in the BNFL design and testing philosophy. This involvement allows operations personnel to become knowledgeable in the features and limitations of systems and components. The development of facility control system simulators in advance of facility testing also strengthens the ability and confidence in the performance of the facility control system and operator interfaces. These simulators allow testing of the control systems software offline without risk to personnel or the facility, permit proving of the startup and operational procedures and documentation, and facilitate training of operations and maintenance personnel.

3.10.1.1 Supplier Testing{tc \l4 "3.10.1.1 Supplier Testing}. The architect engineer is responsible for identifying required supplier tests and their acceptance criteria including incorporation of regulatory and quality commitments. Supplier testing is performed in accordance with approved test plans or specifications. The architect engineer is responsible for final acceptance of supplier testing results.

3.10.1.2 Construction Testing{tc \l4 "3.10.1.2 Construction Testing}. (*The specific tests to be performed, including the purpose, expected results, description of the test, and the equipment* *used will be developed during Part B.)* The TWRS-P construction test plan (*to be developed during Part B)* addresses the development and conduct of the construction testing program. This Plan

1) Describes the approach to testing activities
2) Addresses the duties and responsibilities of participating organizations
3) Describes test requirement and performance result evaluations
4) Provides direction on testing controls.

The construction test plan includes cross-references of test requirements to the applicable test procedure that demonstrates compliance with each requirement. The test organization, reporting to the Construction Manager, is responsible for the following activities:

1) Developing the objectives and scope for construction testing
2) Identifying construction tests to be performed and their acceptance criteria
3) Writing construction test procedures
4) Performing construction tests
5) Reviewing construction test results.

The Construction Manager is responsible for establishing and implementing controls that ensure safety during the execution of construction testing. The test organization manages the construction testing program and interfaces with the operations and operations support organizations to ensure that operational, maintenance, and calibration procedures are validated and that training programs are provided with pertinent information from the testing program.

Tests are sequenced and scheduled taking into account system boundaries, system testing requirements, testing activity interfaces, and nontesting project activities such as critical path construction turnover. Incomplete work, test exceptions, outstanding approved design modifications (and resultant retest requirements), temporary modifications, and other significant open items on each system are tracked. Tracking process entries are part of the comprehensive system status reports provided for review during the preoperational safety review process. As the basic documents of the construction test program, test procedures direct performance activities (e.g., initial conditions, sequence of testing, applicable precautions, recovery actions, test methods, and acceptance criteria). Test specifications, test procedures, and test reports are controlled, approved, and released in accordance with TWRS-P Facility construction test plan.

Test results are reviewed in accordance with the TWRS-P Facility construction test plan to confirm that the test and the results meet established requirements and that sufficient data are obtained to proceed with further testing. Records of the test program are maintained in accordance with the QAP (as described in Section 3.3, AQuality Assurance@ and 3.8, ARecords Management@).

The TWRS-P Facility construction test plan also addresses qualification and training requirements for construction test personnel. Operations and other support personnel are trained in accordance with the requirements of the TWRS-P Facility training and qualification program (*prepared during Part B*). Operator involvement in testing activities provides exceptional training opportunities because of the presence of less significant hazards and the opportunity for access to areas and equipment that will be inaccessible during future waste-handling operations.

3.10.1.3 Startup Testing{tc \l4 "3.10.1.3 Startup Testing}. (*The specific tests to be performed, including the purpose, expected results, description of the test, and the equipment used will be developed during Part B.)* The TWRS-P Facility startup testing manual (*to be developed during Part B)* addresses the development and conduct of process testing during the startup testing program:

1) Describes the overall safety, technical, and management philosophy of the startup testing program

2) Describes the planned approach to testing activities

3) Addresses the duties and responsibilities of participating organizations

4) Describes test result evaluations

5) Provides direction on strict testing controls.

The startup testing phase of the project implements a series of phased system performance demonstrations (SPDs). The SPDs demonstrate the functionality of a process using the required facility systems in an integrated manner. The acceptance criteria for startup testing are derived directly from the process design information produced at the start of the project (see Figure 3-2). At the TWRS-P Facility, the following four levels of SPD will be performed:

Level 1 Process systems using water (cold startup test)
Level 2 Mechanical handling systems (cold startup test)
Level 3 Facility operations using simulants (cold startup test)
Level 4 Facility operations using radioactive materials (hot startup test).

The SPD levels 1 and 2 are applied as appropriate to systems and processes. For example, the first level would not be applied to melters or ventilation systems. Since fourth level SPD is the first time that the facility becomes radioactive, faults identified during previous startup testing can be corrected without decontamination costs or radiological hazards. On successful completion of the fourth level SPD, the facility is ready for normal operation.

System performance demonstration definition documents (SPDDD) define startup tests. The startup organization develops the objectives and scope of the startup testing program for evaluating testing results. The engineering organization prepares the SPDDDs and ensures the demonstration of satisfactory operation of installed safety features. The Operations Startup organization manages the performance of the nonradioactive (cold) and radioactive (hot) startup testing programs. The General Manager is responsible for establishing and implementing controls that ensure safety during the execution of the startup test program.

The SPDDDs identify the intent, objectives, prerequisites, recovery actions, resources, precautions, and sequencing of activities associated with the performance of an SPD. Detailed startup test procedures implement the technical and safety requirements of the SPDDDs and the management controls described in the TWRS-P Facility startup testing manual. They also provide a summary of testing results and confirm that these results are acceptable from the safety and technical viewpoints and demonstrate that the process tested meets the design intent. SPDDDs, startup tests procedures, and test reports are controlled, approved, and released in accordance with TWRS-P Facility startup testing manual.

Test engineers participating in startup testing are trained in accordance with the TWRS-P Facility startup manual. Operations and other support personnel are trained in accordance with the requirements of the TWRS-P Facility training and qualification program.

The SPD stage reports are prepared at the end of each SPD level. These reports summarize the test results and form the basis for the safety committee to review prior to approval to proceed to the next SPD level. A final startup test report provides a complete review of all testing. This report describes how the testing philosophy described in the TWRS-P Facility startup testing manual was implemented. It provides information on the storage and availability of all the detailed startup testing results. Also included is a description of all the significant changes having safety implications made to the facility or process as a result of startup testing. The Project Safety Committee is responsible for review and approval of the final startup test report prior to proceeding to normal operations.

3.10.2 Preoperational Safety Review{tc \l3 "3.10.2 Preoperational Safety Review}

After successful completion of cold startup testing, prior to initial processing of radioactive waste or highly hazardous chemicals (SPD Level 3) an independent preoperational safety review is conducted. This review provides an adequate assessment of readiness to start operations, and ensures that the facility can begin operation without undue risk to the workers, the public, or the environment. The preoperational review is performed by personnel independent of the operating and testing staffs. The review process focuses on the adequacy of hardware, personnel, and administrative processes. During the life of the facility, following significant facility or system modifications, similar preoperational reviews are performed and are in addition to the normal post-modification controls described in Section 3.1, AConfiguration Management.@ Findings identified during preoperational safety reviews are tracked through resolution and closure.

The systematic approach used includes identification of detailed attributes for each facility preparation activity to be evaluated and identification of acceptance criteria for each attribute. The preoperational review process includes an evaluation of the following attributes:

1) Safety Documentation

- An adequate process hazards analysis is performed and resultant recommendations are adequately incorporated.
- Design Class I and II systems are defined and a configuration management process is applied to maintain control over the design and modification of these systems.
- FSAR commitments have been satisfied

2) Personnel

- Sufficient operations personnel are trained and able to support safe facility operations.

- Management programs are established, sufficient numbers of personnel are provided, and adequate facilities and equipment are available to ensure operational support services (e.g., training, maintenance, waste management, environmental protection, industrial safety and hygiene, radiological protection and health physics, emergency preparedness, fire protection, QA, criticality safety, and engineering) are adequate for operations.

- The level of knowledge of operations and operations support personnel is adequate based on reviews of examinations and examination results and selected interviews of operating and operations support personnel.

- A program promotes a culture in which personnel exhibit an awareness of worker and public safety, health, and environmental protection requirements, and through their actions, demonstrate a commitment to comply with these requirements.

- Functions, assignments, responsibilities, and reporting relationships are clearly defined, understood, and effectively implemented (with line management responsibility for control of safety).

3) Hardware and Systems

- All systems are operable, and in satisfactory condition, and a program is in place to confirm and periodically reconfirm the condition and operability of Design Class I and II systems. This includes examinations of records of tests and calibration of these systems.

- A test program that confirms operability of equipment, the viability of procedures, and the training of operators, and confirms that construction and equipment have been designed in accordance with design specifications.

- Modifications to the facility are reviewed for potential impacts on procedures, training, and safety basis.

4) Programs and Procedures

- Adequate and correct procedures are in place for operating the facility.

- Training and qualification programs for operations and operations support personnel are established, documented, and implemented. The training and qualification programs encompass the range of duties and activities required to be performed.

- Adequate and correct emergency and maintenance procedures are in place.

- An emergency operations drill and exercise program, including necessary memoranda of understanding and program records, is implemented.

- A process is established to identify, evaluate, and resolve deficiencies and recommendations made by oversight groups, official review teams, and audit and assessment organizations.

5) Regulatory Compliance

- A systematic review of the facility=s conformance to applicable Federal and state requirements is performed, potential nonconformances are identified, and schedules for gaining compliance are justified in writing and formally approved.

3.11 OPERATIONAL PRACTICES{tc \l2 "3.11 OPERATIONAL PRACTICES}

Conduct of Operations (ConOps) is a set of principles that establishes an overall philosophy for achieving excellence in the operation of the TWRS-P Facility. The ConOps program is implemented to control and conduct operations at the facility and is a major contributor to safety. These principles are summarized below and in other ISAR sections (e.g., control of procedures is addressed in Section 3.9, AProcedures@; control of on-shift training is addressed in Section 3.4, ATraining and Qualification@; and the process for handling events is discussed in Section 3.7, AIncident Investigations@). Detailed guidance on ConOps practices is incorporated into TWRS-P Facility procedures. The overall effectiveness of the ConOPs program is regularly assessed by management, and timely actions are initiated as opportunities for improvements are identified.

The following information represents a summary of the TWRS-P Facility ConOps program. The degree to which each principle described is based on the consequence of the hazards and the complexity of the activities performed by the facility staff. *(Section 3.11 of the FSAR will provide additional details of administrative programs to control and assess operational practices)*.

3.11.1 Operations Organization and Administration{tc \l3 "3.11.1 Operations Organization and Administration}

Excellence in operations is accomplished by management establishing high standards, communicating those standards to the workforce, providing sufficient resources to the operations department, ensuring that personnel are well trained, monitoring operating performance, and holding workers and their managers accountable for their performance in conducting activities. TWRS-P Facility procedures *(to be developed in the Part B)* address the issues of operational staff roles, authorities, and accountability. Section 2.1, AOrganization and Administration,@ discusses the TWRS-P Facility operating organization including the organization of the various staffs required to adequately support facility operations.

The TWRS-P Project Operations Manager is responsible for establishing specific goals and objectives for the operations organization and for assigning responsibility to achieve these objectives. Performance measures are identified to assist in the measurement of success in meeting organizational objectives. Operational personnel are informed of the organizational objectives and their individual responsibility, authority, and accountability relative to these objectives.

The operations personnel training requirements are described in Section 3.4, ATraining and Qualification.@ The shift supervisor training program includes supervisory and managerial training in subjects such as leadership, interpersonal communications, motivation of personnel, and problem analysis, and decision making.

Audits, reviews, investigations, and management assessments are a part of the checks and balances needed in a successful operating program. Management routinely observes personnel performing operating activities. Any deficiencies identified are documented, analyzed, trended, and corrected. In addition, other groups (e.g., QA) periodically review and assess operational performance.

3.11.2 Shift Routines and Operating Practices{tc \l3 "3.11.2 Shift Routines and Operating Practices}

TWRS-P Facility procedures define standards for professional conduct that ensure operator performance meets facility management, customer, and regulator expectations. The procedures also describe aspects of routine operating staff shift activities and watch-standing practices that are important to safety. These practices are summarized in the following subsections.

3.11.2.1 Status Practices{tc \l4 "3.11.2.1 Status Practices}. The operations staff manage, operate, and maintain the facility in a safe and efficient manner. Adherence to operating procedures, TSRs, and LCRs helps to ensure that this objective is accomplished. Workers and management are held accountable for operating performance. Operators and operations shift supervisors promptly notify each other of changes in facility status, operational off-normal conditions, or any difficulties encountered while performing assigned tasks. Alarms associated with TSRs and LCRs are identified as such on the alarm panels. Logbook entries and changes to status boards are used to compile and transmit status information efficiently and accurately.

3.11.2.2 Safety Practices{tc \l4 "3.11.2.2 Safety Practices}. As part of the ConOps program, operators follow the requirements of the industrial safety program, as described in procedures. Appropriate hearing, eye, head, foot, and respiratory protection are worn in designated areas to reduce the potential for injury. Similarly, operators exercise appropriate precautions when working with or around potential hazardous objects (e.g., ladders, electrical equipment, other machines) or hazardous materials (e.g., chemical, and toxic materials) to reduce personal injury. Personnel protection practices ensure that radiological and chemical exposure hazards are maintained as low as reasonably achievable. Strict adherence to procedures and posted personnel protection requirements ensure 1) appropriate use of monitoring instruments, 2) cognizance of permissible exposure levels, 3) proper use of and adherence to radiation work permits and posted areas, and 4) effective and accurate deficiency reporting practices. Radiation protection safety practices are discussed in detail in Section 5.0, ARadiation Safety.@

3.11.2.3 Operator Inspection Tours{tc \l4 "3.11.2.3 Operator Inspection Tours}. Operators conduct periodic inspections of their accessible areas of responsibility to ensure that the status of those areas and their equipment is known. These tours are conducted at scheduled times. During the tours, equipment is inspected to ensure that it is operating properly or, in the case of standby equipment, that it is fully operable. The tour activities include, but are not limited to, local and port inspection, logkeeping, troubleshooting, reporting deficiencies, responding to alarms, and housekeeping. The results of operator tours are documented on roundsheets.

3.11.2.4 Log Sheets{tc \l4 "3.11.2.4 Log Sheets}. Log sheets are used to uniformly record the status and condition of equipment and work areas. Use of operator roundsheets and control area log sheets provide operators guidance on the extent of equipment and areas inspections and a means to record events and status of the inspected areas and equipment. Limits on the sheets inform operators of important control parameters for safe operation. The operators record entries on the sheets to document off-normalities and other items that should be reported to other operating personnel. The round sheets and log sheets are monitored periodically by the supervisory personnel as part of the normal shift routine to ensure that inspection tours are conducted as required, and that out-of-limit parameters are promptly corrected.

3.11.2.5 Response to Indications{tc \l4 "3.11.2.5 Response to Indications}. Instrument readings are considered accurate, and operators respond to them accordingly until inaccuracy is proven. Ignoring an unusual reading because an instrument is believed to be faulty can cause unsafe conditions to go undetected. In general, operators are trained to check other indications, if possible, when unexpected readings are observed. Operators are also trained on instrumentation functions to help them understand potential faults or inaccuracies. Prompt corrective action taken after observing off-normal or unexpected indications is expected to reduce the effects of the off-normality.

3.11.2.6 Resetting Protective Devices{tc \l4 "3.11.2.6 Resetting Protective Devices}. When protective devices (e.g., circuit breakers, fuses) are tripped, efforts are made to understand the cause before resetting the devices. Before action is taken, the operator ensures that no unsafe, off-normal, or extenuating conditions exist that would preclude reset.

3.11.3 Control Area Activities{tc \l3 "3.11.3 Control Area Activities}

Control area activities (both central control room and local workstations) are conducted in a manner that ensures safe and reliable facility operations. Operators are trained to be alert and attentive to indications and alarms. Indicators are monitored frequently, and response to alarms is prompt, to support timely actions to correct alarm conditions. All reasonable actions are taken to clear alarming conditions. Distractions or ancillary duties that compromise an operator's primary responsibilities are minimized to preclude interference with the operator's ability to monitor and respond to facility parameters. Professional behavior is required in designated control areas at all times.

3.11.3.1 Communications{tc \l4 "3.11.3.1 Communications}. Various communication devices are provided for transmission of information within the TWRS-P Facility (e.g., telephones, paging equipment, public address system, horns, bells, sirens, two-way radios). These devices are available in an emergency, yet the devices are controlled to ensure that they do not detract from normal operations. The operating station for each shift position is equipped with adequate communication equipment to assist in the performance of the operator's assigned duties.

All areas of the facility are provided with systems (e.g., horns, bells, sirens) for communicating facility emergencies. In areas where emergency systems cannot be heard, alternate methods are provided for alerting personnel, including flashing lights, personal pagers that vibrate, or persons dedicated to notifications. Emergency communication systems are tested periodically as part of a system surveillance procedure to ensure they are functional.

The use of the public address system is administratively controlled to avoid excessive paging and unnecessary announcements.

3.11.3.2 Control of On-Shift Training{tc \l4 "3.11.3.2 Control of On-Shift Training}. The operator qualification program includes one-on-one instruction on the equipment being operated. The TWRS-P Facility personnel training is supervised and controlled to use the trainees' time effectively to avoid mistakes during training operations, and to ensure that the trainees receive training within the job environment and with as much hands-on experience as possible. Trainees' hands-on activities are immediately suspended during off-normal events, accident conditions, or when the instructor believes suspension is necessary to ensure safe and reliable facility operation. The training has well-defined requirements and objectives for the trainee and is conducted under the supervision and observation of a qualified operator or instructor. The training program is described in more detail in Section 3.4, ATraining and Qualification.@

3.11.4 Control of Equipment and System Status{tc \l3 "3.11.4 Control of Equipment and System Status}

Equipment and facility configuration is maintained within the design requirements through disciplined operation. Operations personnel are knowledgeable of operational limits and their responsibility for actions to ensure compliance with these limits. Operators maintain a knowledge of the status of equipment and operate systems using approved procedures. Shift supervision is responsible for maintaining proper configuration and for authorizing status changes to major equipment and systems that include the SSCs required to maintain the safety envelope as described in Section 4.7, AResults of the Integrated Safety Analysis.@ The shift supervision also ensures that operators possess the necessary protective equipment, procedures, training, and qualifications. Operators are taught that facility safety is to be achieved over facility production. Before first placing equipment or a system into operation, the individual components are checked for proper alignment and readiness for operation. Round sheets, logbooks, status sheets, turnover instructions, and other appropriate documentation provide administrative controls to ensure that operational limits are maintained.

Nonroutine operation occurs only with specific approval by the shift supervision, although operators are taught that during emergencies they are to take specific actions to ensure the safety of personnel, the facility, and the environment without having to obtain prior approval. However, the appropriate supervisory staff are promptly informed of these emergency actions.

Equipment deficiency identification and documentation (e.g., tags, logbooks, and status boards) provide the necessary communication for removing equipment from active service until it is repaired, tested, and returned to service. The status of control panel and local panel alarms are readily available to operating personnel. Administrative controls include instructions for operators during installation of temporary equipment and when equipment is modified. These various forms of communication and administrative controls ensure that operators have the latest information to enable safe operation of the facility.

3.11.5 Lockouts and Tagouts{tc \l3 "3.11.5 Lockouts and Tagouts}

The TWRS-P Facility lockout/tagout program is applicable to servicing and maintenance situations where inadvertent energizing or startup of equipment or release of stored energy could cause injury to employees. These types of evolutions are analyzed and controlled to ensure that personnel injury and equipment damage are prevented. Appropriate lockout and tagout devices are affixed to energy isolation devices to prevent unexpected energizing, startup, or energy release. The TWRS-P Facility procedures provide direction to implement the lockout and tagout analysis and controls. These procedures are applicable to both the startup testing and operations phases of the facility. A similar program is implemented during facility construction. All facility personnel receive periodic training on the lockout/tagout program and management implements strict adherence requirements relative to this program.

3.11.6 Independent Verification{tc \l3 "3.11.6 Independent Verification}

Independent verification is the act of 1) checking that a previous operation established a specified operational status and 2) performing these checks independent of the activities that initially established the operational status. All components in systems that have safety-related functions relied upon for safety are evaluated for the application of independent verification. Independent verification is implemented for valve lineups associated with evolutions that may involve *(...the types of operational activities to be subjected to independent verification will be provided in the Part B FSAR)*. Typically, independent verification is applied to Design Class I and II components following extended shutdowns of equipment, following system modifications, or following maintenance or calibration. Operators are trained to perform independent verification of component positions and to consult the procedures and other reference materials that provide instructions on independent verification techniques. Guidance on and direction for independent verification application is provided in TWRS-P Facility procedures *(to be developed in Part B)*. Each evolution requiring the application of independent verification is identified in the specific applicable operating procedure (*to be developed in Part B).*

3.11.7 Logkeeping{tc \l3 "3.11.7 Logkeeping}

Narrative logsheets are established for key operations shift positions to maintain an accurate history of facility activities and to provide tools for reconstructing off-normal events. The log sheets provide accessible information and data associated with normal operation, testing, and off-normal activities.

3.11.8 Operations Turnover{tc \l3 "3.11.8 Operations Turnover}

Turnover guidelines are established and proceduralized to ensure that information required to adequately perform shift operations is documented by the offgoing shift and reviewed by the oncoming shift. Hence, the operations personnel of the oncoming shift have an accurate picture of overall facility status. Oncoming personnel review documentation such as daily operating roundsheets, logsheets, and checklists before assuming responsibility for their shift position. Offgoing shift supervision and operators are responsible for documenting equipment status, making entries on the roundsheets and logs, and apprising oncoming personnel of equipment status. TWRS-P Facility procedures provide detailed direction on the implementation of proper shift turnover practices and establish a turnover checklist to aid in effective communication of facility status. Shift turnover practices include walkdowns of appropriate control panels by each operator and shift supervisor and a shift briefing conducted by the oncoming shift supervisor following turnover from the offgoing personnel. The shift briefing ensures that operations and support personnel understand shift priorities and objectives.

3.11.9 Operations Aspects of Facility Chemistry and Unique Processes{tc \l3 "3.11.9 Operations Aspects of Facility Chemistry and Unique Processes}

To enhance proper process control of systems, operations personnel must have an understanding of all facility processes (including special tests or short-term campaigns) and must effectively coordinate activities with the technical and process support departments. Properly informed operators are in a unique position to identify early signs of process-related problems or adverse trends. Operators are consulted and advised by technical and process support personnel. A TWRS-P Project policy ensures that support personnel recognize a responsibility to collect and evaluate data prior to an operation and establish criteria that ensure operators are aware of parameter controls and recovery actions. Operators recognize a responsibility to survey and trend required parameters, recognize adverse conditions, take appropriate action, provide timely reports of the condition to management, and record required information.

3.11.10 Required Reading{tc \l3 "3.11.10 Required Reading}

The required reading program provides a method for various types of information applicable to the TWRS-P Facility to be disseminated to pertinent personnel. Types of documents applicable for required reading include selected procedure changes, selected occurrence reports, TSR- and LCR-related changes, and selected training material. TWRS-P Facility managers determine the appropriate material for the required reading list for the staff. The required reading program includes appropriate controls that include a record of acknowledgment for the reader to indicate that the reading has been completed and record retention measures.

3.11.11 Timely Orders to Operators{tc \l3 "3.11.11 Timely Orders to Operators}

Timely orders (also frequently referred to as night orders) allow management to rapidly disseminate essential daily or long-term directions, instructions, or information to operating personnel to support operational activities. Timely orders contain information that is dated, prominently posted, and segregated into daily and long-term orders. A timely order does not change operating procedures but will be incorporated into the appropriate procedure when the information is essential to facility operations.

3.11.12 Operations Procedures{tc \l3 "3.11.12 Operations Procedures}

Section 3.9, AProcedures,@ describes the operations and emergency operating procedures programs used by the TWRS-P Facility operating staff. It describes the development process, content requirements, review and approval process, and requirements for the use of these procedures. In addition, the process for control of procedure changes and revision is described in Section 3.9.

3.11.13 Operator Aid Postings{tc \l3 "3.11.13 Operator Aid Postings}

An operator aid is a posting, diagram, simple schematic, or similar instruction intended to assist operators in performing their duties. Operator aids are informal tools used to provide information to operators but do not establish or modify the facility operations baseline and are, therefore, posted close to the area of expected use. Operator aids are approved by operations management, controlled in an operator aid logbook, and periodically reviewed to ensure that they are correct and necessary. Outdated aids are removed.

3.11.14 Equipment and Piping Labels{tc \l3 "3.11.14 Equipment and Piping Labels}

A standardized equipment labeling program ensures that facility personnel are able to positively identify specific pieces of facility equipment. Design Class I and II equipment labels are clearly distinguished from those of other equipment. Label information meets regulatory requirements and is consistent with equipment descriptions used in facility procedures.

4.0 INTEGRATED SAFETY ANALYSIS{tc \l1 "4.0 INTEGRATED SAFETY ANALYSIS}

Chapter 4.0 provides information on the Tank Waste Remediation System-Privatization (TWRS-P) Facility buildings and chemical processes as they relate to the integrated safety analysis (ISA). Also presented are the methodology for performing the ISA and the results of the ISA, including identified engineered and administrative controls necessary to provide protection for worker and public safety. The integrated safety management plan for the TWRS-P Project is provided in *TWRS-P Privatization Project: Integrated Safety Management Plan, (*BNFL 1997e).

4.1 SITE DESCRIPTION{tc \l2 "4.1 SITE DESCRIPTION}

This section describes the physical characteristics of the TWRS-P Facility site and surrounding area as applicable to the ISA. Much of the site characteristics information used in this Initial Safety Analysis Report (ISAR) section is based on *Hanford Site National Environmental Policy Act (NEPA) Characterization* (Cushing 1995), *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, (Delaney et. al. 1991), and *Canister Storage Building Safety Analysis Report - Phase 3: Safety Analysis Documentation Supporting Canister Storage Building Construction* (Garvin 1997).

4.1.1 Geography{tc \l3 "4.1.1 Geography}

The Hanford Site is a 1,450-km^2 (560-mi^2) area located in the State of Washington (Figure 4-1). The Columbia River enters the Hanford Site boundary at the northwest corner and crosses over to form the eastern boundary as it flows southward. The Yakima River flows from west to east, south of the Hanford Site, and empties into the Columbia River at the conjoined cities of Kennewick, Pasco, and Richland, known collectively as the Tri-Cities. The Hanford Site is bordered on the north by the Saddle Mountains and on the west by the Rattlesnake Hills and the Yakima and Umtanum Ridges. Dominant natural features of the Hanford Site include the Columbia River, anticlinal ridges of basalt in and around the Site, and sand dunes near the Columbia River. The surrounding basaltic ridges rise to 1,100 m (3610 ft).

The location of the Hanford Site with respect to local counties, and regional highways is shown in Figure 4-2. The Hanford Site extends into Benton, Franklin, Grant, and Adams counties.

State Highways 24, 240, and 243 pass through the Hanford Site. There are three commercial airports within 50 km (31 mi) of the TWRS-P Facility site: the Tri-Cities Airport in Pasco, the Richland Airport, and Vista Field in Kennewick.

There are no hospitals, nursing homes, or penal institutions within 20 km (12.4 mi) of the TWRS-P Facility site. The three closest schools, Edwin Markham Elementary School, Cypress Gardens School, and Country Christian School, are at least 20 km (12.4 mi) southeast of the 200 East Area. These schools have a total population of less than 500.

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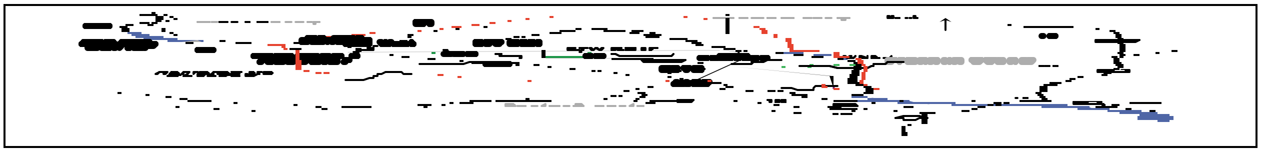

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Land use in the six-county region surrounding the Hanford Site (i.e., Adams, Franklin, Walla Walla, Benton, Yakima, Grant) is predominantly agricultural. More than 75% of the land area in the six-county region is used for agricultural purposes, compared to less than 40% agricultural land use statewide. The main industries in the Tri-Cities are agriculture and energy. Areas of Benton, Franklin, and Yakima Counties near the Hanford Site are irrigated extensively.

4.1.2 Demography{tc \l3 "4.1.2 Demography}

The 1990 U.S. Bureau of the Census population distribution statistics for cities within an 80-km (50-mi) radius of the Hanford Meteorological Station (HMS) are shown in Figure 4-3. The HMS is approximately 7 km (4.3 mi) east of the TWRS-P Facility site.

The population distribution in the area surrounding the Hanford Site is not uniform. Most of the adjacent area to the east, north, and west is farmland or rangeland with scattered farming communities. The major population center of the Tri-Cities is located to the south and southeast of the TWRS P-Facility site. Kennewick, Pasco, and Richland have a combined population of approximately 104,000, based on 1994 estimates. The estimated unincorporated population is 33,000 in Benton County and 18,000 in Franklin County (DOE-RL 1996b).

Approximately 15,000 persons were employed on the Hanford Site in late 1995. Figure 4-4 shows the estimated onsite employee distribution by zones within the 200 East Area as of March 1996. Some Hanford Site job assignments include shift and weekend work, therefore, the total number of persons on the Hanford Site at any one time varies with the time of day, the staffing requirements for active projects, and daily fluctuations in employee work attendance patterns.

4.1.3 Meteorology{tc \l3 "4.1.3 Meteorology}

Most of the Hanford Site, including the TWRS-P Facility site, lies in the Pasco Basin. The climate of the Pasco Basin can be classified as midlatitude semiarid or midlatitude desert, depending on the climatological classification scheme used. Summers are warm and dry with abundant sunshine. Large diurnal temperature variation results from intense solar heating during the day and radiation cooling at night. Daytime high temperatures in June, July, and August periodically exceed 38EC (100EF). Winters are cool with occasional precipitation. Outbreaks of cold air associated with modified arctic air masses can reach the area and cause temperatures to drop below -18EC (0EF). Overcast skies and fog occur periodically during the winter season.

Information contained in this section is taken primarily from *Climatological Data Summary 1995 with Historical Data* (Hoitink and Burk 1996), and *Climatological Summary for the Hanford Site Area* (Stone et. al 1983).

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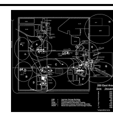

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A wide range of meteorological variables is measured at the HMS and at a 125-m (410-ft) tower, which is located approximately 490 m (1,600 ft) east of the HMS. The location of the HMS is provided in Figure 4-2. Temperature, relative humidity, precipitation, atmospheric pressure, solar radiation, cloud cover, visibility, and subsurface temperature are parameters measured or observed at the HMS. Wind data are measured at various levels on the 125-m (410-ft) tower. Three 60-m (200-ft) towers, with wind and temperature measuring instruments at various levels, are located at the 300, 400, and 100N Areas (Figure 4-1). Wind and temperature measurements also are taken on 23 9.1-m (30-ft) towers distributed around the Hanford Site. Data from all towers are telemetered to the HMS. The Hanford Meteorological Monitoring Network is described in detail in *The Data Collection Component of the Hanford Meteorological Monitoring Program* (Glantz and Islam 1988).

4.1.3.1 Wind. The maximum peak gusts recorded at the HMS are shown in Table 4-1. The highest recorded peak wind gust, measured 15 m (50 ft) above ground level at the HMS, was 35.8 m/s (80 mi/h) in January 1972. Peak wind gusts at 23 other meteorological towers located throughout the Hanford Site have been observed to be as high as 40.7 m/s (91 mi/h). On the basis of peak gusts observed from 1945 through 1980 at 15 m (50 ft) above ground surface, 100-year return period peak gust is estimated to be 38 m/s (85 mi/h), and the 10-year return period peak gust is estimated to be 32 m/s (72 mi/h) (Stone et. al 1983).

Table 4-1. Maximum Peak Gusts 15 m (50 ft) Off the Ground at the HMS for the Period 1945 through 1996[a]

Month	Peak gust speed, mi/h	Direction of peak	Year
January	80	SW	1972
February	65	SW	1971
March	70	SW	1956
April	73	SSW	1972
May	71	SSW	1948
June	72	SW	1957
July	69	WSW	1979
August	66	SW	1961
September	65	SSW	1953
October	63	SSW	1950
November	67	WSW	1993
December	71	SW	1955
Most Limiting Occurrence	80	SW	January 1972

Note: a From D. J. Hoitink and K. W. Burk, 1995, *Climatological Data Summary 1994, with Historical Data*, PNNL-10553, Pacific Northwest National Laboratory, Richland, Washington.

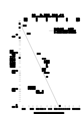
Two probabilistic wind hazard assessments have been completed for the Hanford Site. The first assessment, *Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites* (Coats and Murray 1985) is based on more than 30 years of pre-1979 Hanford Site wind data. The results of this assessment are shown in Figure 4-5. The hazard curves are for wind at 10 m (33 ft) above ground level and are, therefore, lower than the 15 m (50 ft) winds discussed in the previous paragraph.

Methodology for Estimating Extreme Winds for Probabilistic Risk Assessments (Ramsdell et. al 1986) is the other probabilistic wind hazard assessment completed for the U.S. Nuclear Regulatory Commission (NRC) that describes a procedure for estimating extreme wind probabilities. This methodology currently is being used by the NRC. The application of this methodology to Hanford Site data, including post-1979 data, resulted in the hazard curves shown in Figure 4-5. The NRC method results in slightly higher wind speeds than the Coats and Murray study (Coats and Murray 1985).

The minimum straight wind speed recommended by American Society of Civil Engineers (ASCE) is 38 m/s (85 mi/hr) for a 3-sec gust (from *Minimum Design Loads for Buildings and Structures* [ASCE 1995]). Figure 4-5 shows that this wind has a probability of exceedence of about 1.3 X 10^{-3} (about 770 years return period). The design-basis straight wind for structures, systems, and components (SSC) with natural phenomena hazards (NPH) safety functions is a 42 m/s (95 mi/hr) 3-sec gust at a height of 10 m (33 ft) above ground surface, which has a return period of about 6,500 years (1.5 X 10^{-4}). This value is consistent with *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE-STD-1020-94, (DOE 1994b). Nonreactor SSCs equivalent to Design Class I are to be designed to the windspeed with an annual probability of exceedance of 10^{-3} (1,000-yr return period) or 42 m/sec (95 mi/hr) 3-sec gust, whichever is greater. A 6.8-kg (15-lb), 5- x 10-cm timber plank (2 x 4 in.) missile, with a trajectory height of 9 m (30 ft) at 22 m/s (50 mi/hr) is the design-basis wind-driven missile for SSCs with NPH safety functions.

The design-basis straight wind for SSCs without NPH safety functions is 38 m/s (85 mi/hr) 3-sec gust at a height of 10 m (33 ft) above ground surface. The basis for this wind speed is ASCE 7-95 (ASCE 1995) and the Uniform Building Code (UBC) (ICBO 1994).

As shown in Figure 4-5, the tornado wind speed exceeds the straight wind speed at a probability of about 10^{-5} or about every 100,000 years. Because of the low probability and relatively low wind speed of a tornado (from the *Tornado Climatology of the Contiguous United States* [Ramsdell and Andrews 1986]), no tornado design requirements are applied to the TWRS-P Facility. The U.S. Department of Energy (DOE) currently is reassessing their tornado hazard assessment methods. If the results of this work impact the tornado design requirements for the Hanford Site, the criteria will be reviewed. DOE-STD-1020-94 states that, AIf the annual exceedance probability at the intersection of the curves is greater than or equal to $2x10^{-5}$ (50,000 years return period), tornado design criteria are specified@. The crossover for the more conservative NRC method Hanford curves is $8x10^{-6}$ (125,000 yrs return period).



4.1.3.2 Precipitation. The annual average precipitation at the HMS is 17.3 cm (6.8 in.) with the wettest year (1995) being 31 cm (12.3 in.) and the driest (1976) being 7.6 cm (3.0 in.). On the average, 54% of normal annual precipitation falls during November through February. Monthly averaged and extreme precipitation amounts for the Hanford Site from 1945 through 1995 are presented in Table 4-2.

Table 4-2. Hanford Site Average Precipitation for 1945-1995 and Extreme Precipitation for Specified Years[a]

Average			Maximum			Minimum		
Time span	mm	in.	Year	mm	in.	Year	mm	in.
January	24.9	0.98	1970	62.7	2.47	1977	2.00	0.08
February	15.7	0.62	1961	53.3	2.10	1988	T[b]	T[b]
March	12.7	0.50	1957	47.2	1.86	1968	0.50	0.02
April	11.7	0.46	1995	39.1	1.54	1986	T[b]	T[b]
May	13.5	0.53	1972	51.6	2.03	1992	T[b]	T
June	13.7	0.54	1950	74.2	2.92	1986	T[b]	--
July	5.6	0.22	1993	44.7	1.76	1980	T[b]	T[b]
August	6.4	0.25	1977	34.5	1.36	1988	0.00[b]	0.00[b]
September	8.1	0.32	1947	34.0	1.34	1991	0.00[b]	0.00
October	13.7	0.54	1957	69.1	2.72	1987	T[b]	T[b]
November	21.8	0.86	1973	67.1	2.64	1976	T	T
December	24.9	0.98	1964	59.4	2.34	1976	2.8	0.11
Year	170.9	6.73	1995	312.7	12.31	1976	75.9	2.99

Notes:
a. From Hointink and Burk 1996, *Climatological Data Summary 1995, with Historical Data*, PNL-11107, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.
b. Most recent of multiple occurrences.
T = trace (0.13 mm [0.005 in.] or less).

Total annual snowfall, which includes all frozen precipitation, varies from a low of 0.76 cm (0.3 in.) to 142 cm (56.1 in.). The average annual snowfall is 38 cm (15 in.). The record snow monthly snowfall at HMS is 55.9 cm (22 in.) in December 1996, but the record monthly snowfall on the Hanford Site is 61 cm (24 in.) in February 1916. The record seasonal ground snow is 39.6 cm (15.6 in.) in December 1985. The monthly and seasonal snowfall at the HMS is shown in Table 4-3.

Table 4-3. Monthly and Seasonal Snowfall at the HMS in Inches, Average and Maximum for the Period 1945 through 1996[a]

Month	Average	Maximum	Year	Maximum 24-hour	Year
January	5.1	23.4	1950	7.1	1954
February	2.5	17.0	1989	10.2	1993
March	0.5	4.2	1951	2.7	1989
April	T	1.0	1982	b	--
May	0	0	--	0	--
June	0	0	--	0	--
July	0	0	--	0	--
August	0	0	--	0	--
September	0	0	--	0	--
October	0.1	1.5	1973	1.5	1973
November	1.8	18.3	1985	8.8	1985
December	5.4	22.6	1996	6.6	1985
Year	14.8	56.1	1992-93	10.2	February 1993

Notes:
a. From D. J. Hoitink and K. W. Burk, 1997, *Climatological Data Summary 1996, with Historical Data*, PNNL-11471, Pacific Northwest National Laboratory, Richland, Washington, updated through 1996.
b. No value given for maximum 24-hour snowfall.

The ASCE recommended minimum ground snow load applicable to the Hanford Site is 75 kg/m^2 (15.4 lbm/ft^2) (ASCE 1995). This is the design-basis ground snow load for Design Class I and II SSCs with and without NPH safety functions.

A recent cooperative study by the National Oceanic and Atmospheric Administration, the Bureau of Reclamation, and the U.S. Army Corps of Engineers has updated the probable maximum precipitation (PMP) estimates for the Pacific Northwest in *Probable Maximum Precipitation **C** Pacific Northwest States* (Hansen et. al 1994). This document supersedes earlier work done by these organizations and is the source used for the PMP shown in Table 4-4. The PMP values are estimates of the maximum precipitation physically possible for both general storms (large air mass interactions) and local storms (unstable air, thunderstorms).

No annual probability of exceedance is given in Hansen et. al 1994 for the PMP for either general or local storms. The PMP is conservatively assumed to have an annual probability of exceedance of less than 1 x 10^{-6} (*Evaluation Procedures for Hydrologic Safety of Dams* [ASCE 1988]).

Table 4-4. Extreme Precipitation Estimates for the Hanford Site

Time	PMP 24-hour general storm (10 mi^2)[a]	PMP local storm (1 mi^2)[a]	PMP local storm (10 mi^2)[a]	25-year average return period[b]	100 Year average return period[b]	1,000-year average return period[b]
15 minutes	--	4.0	3.2	--	--	--
20 minutes	--	--	--	0.47	0.60	0.80
30 minutes	--	6.0	4.8	--	--	--
45 minutes	--	7.2	5.8	--	--	--
1 hour	1.6	8.0	6.4	0.62	0.81	1.11
6 hours	4.7	9.2	7.4	1.21	1.59	2.20
24 hours	8.0	--	--	1.56	1.99	2.68
48 hours	9.6	--	--	--	--	--
72 hours	10.4	--	--	--	--	--

Notes: Precipitation depths are in inches. To convert to centimeters, multiply by 2.54. The areas provided are the areas over which the precipitation is assumed to occur. The 10 mi^2 value is usually used for runoff calculations.

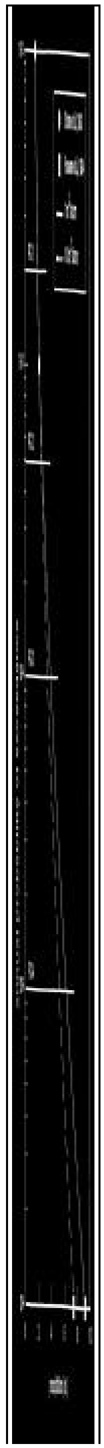
a. From Hansen, E. M., D. D. Fenn, P. Corrigan, J. L. Vogel, L. C. Schreiner, and R. W. Stodt, 1994, *Probable Maximum Precipitation - Pacific Northwest States*, Hydrometeorological Report No. 57, National Weather Service, Silver Spring, Maryland.

b. From Stone, W. A., J. M. Thorp, O. P. Gifford, and D. J. Hoitink, 1983, *Climatological Summary for the Hanford Area,* PNL-4622, Pacific Northwest Laboratory, Richland, Washington.

PMP = probable maximum precipitation.

The more frequent extreme precipitation values shown in Table 4-4 are from Stone et. al (1983) and are based on the analysis of extreme values from 22 years of meteorological data from the HMS. Although these values cannot be compared directly with either the 2.6 km^2 (1-mi^2) storm or the 2.60 km^2 (10-mi^2) storm, they provide a data-based estimate for extreme precipitation on the 200 Areas Plateau. A 6-hr precipitation hazard curve is estimated using the 100-yr and 1,000-yr average return period values (10^{-2} and 10^{-3} annual probability of exceedance respectively) of Stone et. al (1983) and the 6-hr PMP at an assumed frequency of 10^{-6}/yr (Figure 4-6).

The design-basis precipitation for SSCs with NPH safety functions is 10 cm (3.9 in.) within 6 hrs. This value is the 10^{-4} probability rainfall and is less than PMP as shown in Figure 4-6. The 10^{-4} criterion meets the DOE flooding criterion for Performance Category III SSCs (DOE 1994c). The design basis precipitation for SSCs without NPH safety functions is 6.4 cm (2.5 in.) within 6 hours. This value is the 5 x 10^{-4} annual probability rainfall, which meets the DOE flooding criterion for Performance Category 4 SSCs (DOE 1994b).



4.1.3.3 Severe Weather. Dust and blowing dust (locally resuspened) occur frequently, with blowing dust the most commonly observed. Dust and blowing dust are recorded at HMS when horizonal visibility is reduced to 9.7 km (6mi) or less. Dust is carried into the area from distant sources and may or may not occur during strong winds. Dust has been observed with wind speeds ranging from 1.8 m/s (4mi/h) to 13.4 m/s (30 mi/h). Blowing dust occurs when dust is resuspended locally by strong winds. Wind speeds during blowing dust range from 8.5 m/s (20 mi/h) to gusts of 35.8 m/s(80 mi/h). The average number of days per year with dust or blowing dust is five. The greatest number of such days in any year is 20, while the fewest is 0. The greatest number of days with dust or blowing dust occur most frequently between March and May and in September. Dust and blowing dust occurs least frequently during November and December.

4.1.3.4 Short-Term Diffusion Estimates. Atmospheric diffusion factors (x/Q) have been calculated for the TWRS-P Facility for evaluation of radiological accident consequences to co-located workers and the public. Calculations were performed for stack and ground-level releases with and without building wake effects and plume meander. Both 99.5% sector-specific and 95% overall site values were calculated; in all cases, the 99.5% sector-specific values were found to be the most limiting. For a ground level release, the co-located worker was assumed to be located at 100 m (328 ft). For a stack release, the location of the co-located worker was that location resulting in the most limiting atmospheric diffusion factor. The assumed location of the public receptor is shown in Figure 4-2. The x/Q were determined using the GXQ code, Version 4.0A (Hey 1995). The following TWRS-P Facility-specific parameters were used for the GXQ runs:

1) Stack height 88 m (289 ft)
2) Stack air flow 5.56 m^3/s (196 ft^3/s)
3) Stack diameter 0.60 m (2 ft)
4) Stack air temperature 20EC (68EF)
5) Building dimension; 35.1 m (115 ft) high by 249.8 m (819.6 ft) long.

The following GXQ logical choices and adjustment models were made true or turned on:

1) Joint frequency used to compute frequency to exceed ÷/Q

2) NRC RG 1.145 building wake and plume models, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,* (NRC, Regulatory Guide 1.145, [NRC 1982])

The Version 4.0A of the GXQ code uses data obtained at the HMS for 1983 to 1991. Tables 4-5 and 4-6 list the results provided by the GXQ code for ground-level and stack releases, respectively. The specific x/Q used for the accident analysis discussed in Section 4.7, AResults of the Integrated Safety Assessment@ are provided in Table 4-7. Data used by Version 4.0A of the GXQ code are summarized in Tables 4-8 through 4-10. These three tables provide the joint frequency distributions for the HMS data collected between 1983 and 1991 at the 10-m (3.28-ft), 61-m (200-ft), and 89-m (292-ft) elevations of the HMS tower.

Table 4-5. Atmospheric Dispersion Factors (÷/Q) - Ground Level

Release	Receptor Type	Distance (m)	Direction	Percent	÷/Q (s/m^3)	Comment
Ground level	maximum site boundary	11941	SE	99.5 (sector-specific)	1.88E-05	no BW, no PM
Ground level	maximum site boundary	11941	SE	99.5 (sector-specific)	1.50E-05	BW, PM
Ground level	maximum onsite at 100 m	100	E	99.5 (sector-specific)	3.41E-02	no BW, no PM
Ground level	maximum onsite at 100 m	100	E	99.5 (sector-specific)	8.55E-03	BW, PM
Ground level	maximum onsite $ 100 m	100	E	99.5 (sector-specific)	3.41E-02	no BW, no PM
Ground level	maximum onsite $ 100 m	100	E	99.5 (sector-specific)	8.55E-03	BW, PM
Ground level	maximum site boundary	13215	All	95 (overall site)	1.69E-05	no BW, no PM
Ground level	maximum site boundary	13215	All	95 (overall site)	1.38E-05	BW, PM
Ground level	maximum onsite at 100 m	100	All	95 (overall site)	3.28E-02	no BW, no PM
Ground level	maximum onsite at 100 m	100	All	95 (overall site)	8.31E-03	BW, PM
Ground level	maximum onsite $ 100 m	100	All	95 (overall site)	3.28E-02	no BW, no PM
Ground level	maximum onsite $ 100 m	100	All	95 (overall site)	8.31E-03	BW, PM

Notes:
BW = Building wake model used.
PM = Plume meander model used.
13,215 m = 8.21 mi
11,941 m = 7.42 mi
100 m = 328 ft

Table 4-6. Atmospheric Dispersion Factors (÷/Q) - Stack Release

Release	Receptor Type	Distance (m)	Direction	Percent	÷/Q (s/m^3)	Comment
Stack	maximum site boundary	11111	S	99.5 (sector-specific)	2.69E-06	no BW, no PM
Stack	maximum site boundary	11111	S	99.5 (sector-specific)	2.44E-06	BW, PM
Stack	maximum onsite at 100 m	100	W	99.5 (sector-specific)	2.00E-10	no BW, no PM
Stack	maximum onsite at 100 m	100	SE	99.5 (sector-specific)	8.92E-12	BW, PM
Stack	maximum onsite $ 100 m	360	W	99.5 (sector-specific)	1.52E-05	no BW, no PM
Stack	maximum onsite $ 100 m	420	W	99.5 (sector-specific)	1.21E-05	BW, PM
Stack	maximum site boundary	13215	All	99 (overall site)	2.39E-06	no BW, no PM
Stack	maximum site boundary	13215	All	99 (overall site)	2.21E-06	BW, PM
Stack	maximum onsite at 100 m	100	All	99 (overall site)	1.15E-10	no BW, no PM
Stack	maximum onsite at 100 m	100	All	99 (overall site)	5.89E-12	BW, PM
Stack	maximum onsite $ 100 m	340	All	99 (overall site)	1.13E-05	no BW, no PM
Stack	maximum onsite $ 100 m	380	All	99 (overall site)	9.20E-06	BW, PM

Notes:
BW = Building wake model used.
PM = Plume meander model used.
13215 m = 8.21 mi
11111 m = 6.9 mi
420 m = 1378 ft
380 m =1247 ft
360 m = 1181 ft
340 m = 1116 ft
100 m = 328 ft

4.1.4 Hydrology{tc \l3 "4.1.4 Hydrology}

This section presents the surface water and hydrostratigraphy (water and soil characteristics) of the Hanford Site, focusing on the characteristics of the unsaturated zone or vadose zone and the saturated zone or groundwater. *Geology and Aquifer Characteristics of the Grout Treatment Facility* (Lindberg et. al 1993) provides more detailed hydrologic data for the location of the TWRS-P Facility.

The Columbia River and its tributary, the Yakima River, are the primary Hanford Site surface water features (see Figure 4-7). West Lake, about 0.04 km^2 (10 acres) and less than 1m (3.3 ft) deep, is the only natural lake on the Hanford Site. Artificial surface water bodies include ponds and ditches created and used for wastewater disposal.

The vadose zone (the zone of unsaturated sediments between the water table and the ground surface) at the Hanford Site is comprised mainly of unconsolidated gravels and sands. The thickness of the vadose zone ranges from no thickness at the Columbia River bank and West Lake to more than 100 m (330 ft) at the 200 East and 200 West Areas.

Table 4-7. Airborne Dispersion Coefficients for the TWRS-P Facility

Receptor	Location/ Direction	Release Type	÷/Q (s/m^3)	
			Without Plume Meander and Building Wake	With Plume Meander and Building Wake
Public	11.9 km SE (7.42 mi)	Ground	1.88×10^{-5}	1.50×10^{-5}
Co-located Worker	100 m E (328 ft)	Ground	3.41×10^{-2}	8.55×10^{-3}
Public	11.1 km S (6.9 mi)	Stack	2.48×10^{-6}	2.25×10^{-6}
Co-located Worker	380 m W (1247 ft)	Stack	1.24×10^{-5}	NA
Co-located Worker	440 m W (1444 ft)	Stack	NA	9.56×10^{-6}

Saturated sediments make up a series of aquifers (permeable bodies of rock) and aquitards (beds of low permeability adjacent to an aquifer). Sand- and gravel-dominated stratigraphic units form aquifers, and fine-grained deposits form aquitards. The shallowest suprabasalt aquifer is unconfined beneath most of the Hanford Site. Confined aquifers are present in sedimentary interbeds and interflow zones between dense basalt flows. The main water-bearing portions of the interflow zones are networks of interconnecting vesicles and fractures of the flow tops and flow bottoms.

4.1.4.1 Surface Water. {tc \l4 "4.1.4.1 Surface Water. }In the past, there were numerous artificial surface water bodies (e.g., cribs, ponds, ditches) in the 200 East and 200 West Areas. Effluent disposal wastewater infiltrated the ground and, in many instances, affected groundwater flow and chemistry. Today, only B Pond and the Treated Effluent Disposal Facility located east of 200 East Area, and a Washington State-approved land disposal site located in the 200 West Area receive significant volumes of effluent.

The Columbia River originates in the mountains of eastern British Columbia, Canada, and drains an area of approximately 70,800 km^2 (27,300 mi^2) en route to the Pacific Ocean. The average annual flow of the Columbia River is 1.1×10^{11} m^3 (3.9×10^{12} ft^3) where it enters the Hanford Site and 1.6×10^{11} m^3 (5.6×10^{12} ft^3) where it exits the site. The river elevation is approximately 120 m (396 ft) near the 100-B and -C Areas and approximately 104 m (341 ft) at the 300 Area.

Flow on the Columbia River is regulated by three upstream dams in Canada and by seven upstream dams in the U.S. The Hanford Reach (the free flowing portion of the river) is approximately 81 km (50 mi) in length and extends from Priest Rapids Dam to just north of the 300 Area. Flow through the Hanford Reach fluctuates significantly and is controlled at Priest Rapids Dam.

Table 4-8. Joint Frequency Distribution for the HMS, 10 m (3.28 ft), 1983-1991[a]

Percentage of Time Wind Blows from the 200 Areas Towards the Direction Indicated																	
Midpoint Wind Speed Class (m sec $^{-1}$)	Pasquill Category	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.89	A	0.36	0.20	0.23	0.26	0.40	0.24	0.17	0.10	0.10	0.06	0.06	0.06	0.10	0.10	0.14	0.22
	B	0.15	0.13	0.10	0.11	0.16	0.09	0.07	0.03	0.05	0.02	0.01	0.03	0.04	0.05	0.07	0.10
	C	0.14	0.10	0.09	0.12	0.14	0.10	0.06	0.04	0.04	0.02	0.02	0.02	0.04	0.04	0.10	0.10
	D	0.87	0.58	0.59	0.59	0.77	0.50	0.43	0.32	0.27	0.19	0.21	0.17	0.40	0.44	0.54	0.55
	E	0.39	0.28	0.28	0.25	0.46	0.34	0.31	0.30	0.34	0.21	0.25	0.29	0.49	0.44	0.45	0.39
	F	0.23	0.12	0.12	0.14	0.31	0.23	0.28	0.26	0.35	0.23	0.22	0.27	0.48	0.36	0.32	0.23
	G	0.10	0.04	0.08	0.08	0.13	0.13	0.13	0.14	0.17	0.09	0.10	0.09	0.22	0.14	0.14	0.09
2.7	A	0.69	0.44	0.29	0.32	0.60	0.51	0.45	0.29	0.24	0.12	0.17	0.19	0.25	0.30	0.42	0.48
	B	0.21	0.15	0.06	0.08	0.16	0.13	0.13	0.09	0.08	0.04	0.03	0.05	0.07	0.09	0.16	0.16
	C	0.19	0.12	0.06	0.09	0.13	0.13	0.19	0.10	0.06	0.02	0.03	0.05	0.08	0.10	0.19	0.15
	D	0.84	0.48	0.40	0.33	0.66	0.57	0.75	0.53	0.35	0.18	0.24	0.28	0.69	1.09	1.05	0.77
	E	0.32	0.17	0.11	0.13	0.31	0.34	0.47	0.52	0.46	0.21	0.29	0.48	1.58	1.68	1.11	0.39
	F	0.13	0.05	0.05	0.05	0.16	0.21	0.39	0.44	0.45	0.21	0.27	0.46	1.60	1.69	0.82	0.25
	G	0.04	0.02	0.02	0.03	0.09	0.10	0.20	0.23	0.20	0.08	0.10	0.20	0.82	0.69	0.30	0.08
4.7	A	0.26	0.24	0.10	0.03	0.08	0.10	0.10	0.13	0.12	0.07	0.14	0.34	0.35	0.35	0.40	0.17
	B	0.09	0.06	0.03	0.01	0.03	0.03	0.04	0.05	0.03	0.02	0.05	0.07	0.10	0.14	0.12	0.06
	C	0.08	0.05	0.03	0.01	0.02	0.02	0.04	0.04	0.05	0.02	0.03	0.06	0.09	0.13	0.12	0.03
	D	0.32	0.20	0.09	0.04	0.12	0.11	0.25	0.27	0.24	0.13	0.23	0.39	0.83	1.46	0.84	0.21
	E	0.19	0.09	0.04	0.01	0.06	0.06	0.15	0.25	0.22	0.12	0.18	0.39	1.98	2.50	0.75	0.13
	F	0.04	0.06	0.01	0.01	0.01	0.02	0.05	0.17	0.14	0.03	0.07	0.20	1.19	1.60	0.32	0.06
	G	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.09	0.07	0.01	0.02	0.09	0.56	0.84	0.13	0.01
7.2	A	0.07	0.07	0.05	0.01	0.00	0.00	0.01	0.03	0.04	0.04	0.11	0.25	0.25	0.25	0.33	0.05
	B	0.02	0.03	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.01	0.04	0.08	0.06	0.07	0.09	0.01
	C	0.02	0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.07	0.06	0.07	0.06	0.01
	D	0.10	0.10	0.03	0.01	0.00	0.01	0.03	0.07	0.10	0.11	0.25	0.38	0.58	1.14	0.50	0.05
	E	0.07	0.12	0.01	0.00	0.00	0.00	0.01	0.05	0.07	0.08	0.17	0.30	0.65	1.75	0.41	0.02
	F	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.01	0.02	0.07	0.08	0.03	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
9.8	A	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.05	0.16	0.10	0.11	0.24	0.00
	B	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.02	0.03	0.06	0.00
	C	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.05	0.02	0.03	0.05	0.00
	D	0.02	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.16	0.24	0.13	0.50	0.29	0.01
	E	0.01	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.11	0.15	0.06	0.38	0.11	0.00
	F	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.	A	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.02	0.02	0.03	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.01	0.00
	C	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.01	0.00
	D	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.09	0.03	0.07	0.08	0.00
	E	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.02	0.01	0.05	0.03	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.	A	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00
	B	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	D	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.02	0.00	0.00	0.00
	E	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	F	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.	A	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4-8. Joint Frequency Distribution for the HMS, 10 m (3.28 ft), 1983-1991[a]

Percentage of Time Wind Blows from the 200 Areas Towards the Direction Indicated																	
	B	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.04	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	E	0.07	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note
a: From Schreckhise, R.G, K. Rhoads, J.S. Davis, B. A. Napier, and J.V. Ramsdell, 1993, *Recommended Dose Calculation Methods and Hanford-Specific Parameters*, PNL-3777, Revision 2, Pacific Northwest Laboratory, Richland, Washington.

Table 4-9. Joint Frequency Distribution for the HMS, 61 m (200 ft), 1983-1991[a]

Percentage of Time Wind Blows from the 200 Areas Towards the Direction Indicated																	
Midpoint Wind Speed Class (m sec^{-1})	Pasquill Category	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.89	A	0.35	0.18	0.20	0.24	0.38	0.23	0.17	0.09	0.10	0.06	0.05	0.06	0.10	0.10	0.12	0.18
	B	0.12	0.10	0.09	0.10	0.13	0.08	0.06	0.03	0.05	0.02	0.01	0.02	0.04	0.05	0.06	0.08
	C	0.11	0.08	0.07	0.10	0.13	0.09	0.07	0.04	0.03	0.02	0.02	0.03	0.04	0.03	0.08	0.08
	D	0.62	0.42	0.39	0.45	0.60	0.41	0.36	0.27	0.21	0.16	0.17	0.12	0.26	0.32	0.42	0.39
	E	0.23	0.16	0.17	0.15	0.31	0.26	0.23	0.27	0.27	0.16	0.16	0.19	0.31	0.28	0.24	0.22
	F	0.13	0.08	0.08	0.09	0.19	0.20	0.28	0.31	0.33	0.16	0.16	0.21	0.40	0.29	0.23	0.15
	G	0.07	0.03	0.05	0.05	0.12	0.11	0.16	0.21	0.20	0.09	0.09	0.10	0.25	0.14	0.12	0.07
2.7	A	0.60	0.40	0.29	0.33	0.59	0.52	0.42	0.24	0.20	0.11	0.14	0.14	0.20	0.24	0.35	0.43
	B	0.18	0.13	0.06	0.09	0.16	0.12	0.11	0.07	0.07	0.03	0.02	0.04	0.06	0.07	0.14	0.13
	C	0.18	0.11	0.06	0.10	0.13	0.13	0.15	0.07	0.05	0.02	0.02	0.04	0.05	0.08	0.16	0.15
	D	0.81	0.42	0.39	0.32	0.63	0.50	0.62	0.37	0.29	0.13	0.16	0.22	0.42	0.59	0.71	0.68
	E	0.26	0.13	0.14	0.13	0.27	0.26	0.25	0.30	0.32	0.14	0.21	0.29	0.58	0.60	0.57	0.28
	F	0.15	0.06	0.05	0.04	0.16	0.12	0.20	0.30	0.28	0.16	0.19	0.26	0.64	0.57	0.37	0.17
	G	0.04	0.02	0.03	0.03	0.07	0.07	0.10	0.11	0.11	0.06	0.07	0.12	0.46	0.27	0.14	0.06
4.7	A	0.35	0.27	0.11	0.05	0.12	0.10	0.14	0.15	0.14	0.07	0.15	0.29	0.30	0.31	0.34	0.22
	B	0.11	0.08	0.03	0.01	0.04	0.05	0.06	0.06	0.03	0.02	0.05	0.06	0.08	0.10	0.11	0.09
	C	0.09	0.06	0.04	0.02	0.03	0.02	0.06	0.05	0.05	0.02	0.02	0.03	0.07	0.08	0.12	0.05
	D	0.38	0.26	0.14	0.07	0.17	0.16	0.27	0.24	0.20	0.11	0.19	0.25	0.61	0.90	0.79	0.34
	E	0.20	0.11	0.05	0.04	0.12	0.13	0.23	0.23	0.23	0.11	0.15	0.31	1.05	0.95	0.65	0.25
	F	0.08	0.03	0.02	0.03	0.05	0.09	0.11	0.17	0.19	0.10	0.13	0.27	0.89	0.92	0.44	0.13
	G	0.01	0.01	0.01	0.01	0.01	0.02	0.05	0.07	0.06	0.02	0.05	0.10	0.49	0.38	0.15	0.04
7.2	A	0.11	0.11	0.05	0.02	0.01	0.02	0.02	0.06	0.06	0.05	0.10	0.25	0.25	0.26	0.32	0.07
	B	0.05	0.04	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.03	0.05	0.07	0.10	0.08	0.03
	C	0.03	0.03	0.02	0.00	0.01	0.00	0.01	0.02	0.02	0.01	0.02	0.07	0.08	0.11	0.06	0.01
	D	0.19	0.13	0.06	0.01	0.03	0.02	0.10	0.20	0.15	0.09	0.20	0.32	0.59	1.11	0.54	0.11
	E	0.13	0.08	0.03	0.02	0.04	0.04	0.11	0.17	0.13	0.09	0.15	0.31	1.52	1.67	0.62	0.12
	F	0.04	0.03	0.01	0.01	0.03	0.02	0.07	0.10	0.09	0.03	0.06	0.15	0.92	1.03	0.32	0.07
	G	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.04	0.01	0.01	0.05	0.28	0.51	0.13	0.01
9.8	A	0.03	0.05	0.04	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.07	0.14	0.15	0.15	0.23	0.02
	B	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.06	0.05	0.04	0.06	0.00
	C	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.01	0.04	0.04	0.04	0.05	0.00
	D	0.06	0.06	0.01	0.01	0.00	0.01	0.03	0.06	0.07	0.08	0.16	0.29	0.47	0.81	0.35	0.04
	E	0.09	0.09	0.01	0.00	0.01	0.00	0.06	0.08	0.08	0.07	0.13	0.24	0.99	1.92	0.41	0.03
	F	0.03	0.03	0.00	0.00	0.01	0.00	0.02	0.05	0.04	0.01	0.02	0.06	0.45	0.72	0.13	0.01
	G	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.02	0.13	0.29	0.04	0.00
13.	A	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.14	0.08	0.09	0.19	0.00

	B	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.04	0.02	0.03	0.05	0.00
	C	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.04	0.01	0.02	0.04	0.00
	D	0.02	0.04	0.01	0.01	0.00	0.00	0.00	0.02	0.04	0.07	0.15	0.23	0.25	0.77	0.37	0.02
	E	0.05	0.08	0.02	0.00	0.00	0.00	0.02	0.03	0.03	0.04	0.11	0.19	0.36	1.26	0.30	0.01
	F	0.02	0.03	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.01	0.02	0.12	0.29	0.03	0.01
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.13	0.01	0.00
16.	A	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.02	0.02	0.05	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.00
	C	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.01	0.02	0.00
	D	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.13	0.13	0.04	0.29	0.14	0.00
	E	0.01	0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.07	0.10	0.06	0.30	0.10	0.00
	F	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.03	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00
19.	A	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.01	0.01	0.00
	B	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
	C	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
	D	0.03	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.07	0.04	0.03	0.02	0.00
	E	0.02	0.06	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.04	0.02	0.01	0.03	0.01	0.00
	F	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
	G	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note
a: From Schreckhise, R.G, K. Rhoads, J.S. Davis, B. A. Napier, and J.V. Ramsdell, 1993, *Recommended Dose Calculation Methods and Hanford-Specific Parameters*, PNL-3777, Revision 2, Pacific Northwest Laboratory, Richland, Washington.

Table 4-10. Joint Frequency Distribution for the HMS, 89 m (292 ft), 1983-1991[a]

Percentage of Time Wind Blows from the 200 Areas Towards the Direction Indicated																	
Midpoint Wind Speed Class (m sec $^{-1}$)	Pasquill Category	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.89	A	0.34	0.16	0.19	0.24	0.38	0.23	0.17	0.10	0.10	0.05	0.05	0.06	0.10	0.10	0.12	0.17
	B	0.12	0.09	0.09	0.10	0.13	0.09	0.06	0.02	0.05	0.02	0.01	0.02	0.04	0.05	0.06	0.08
	C	0.11	0.09	0.08	0.10	0.13	0.09	0.07	0.04	0.03	0.02	0.02	0.02	0.05	0.03	0.08	0.07
	D	0.62	0.40	0.39	0.45	0.61	0.41	0.36	0.28	0.21	0.16	0.16	0.11	0.25	0.33	0.39	0.39
	E	0.22	0.16	0.16	0.15	0.30	0.26	0.25	0.28	0.27	0.15	0.16	0.17	0.30	0.30	0.27	0.22
	F	0.13	0.08	0.08	0.09	0.19	0.19	0.25	0.29	0.32	0.15	.016	0.19	0.41	0.34	0.27	0.15
	G	0.07	0.02	0.05	0.05	0.11	0.12	0.16	0.22	0.18	0.08	0.09	0.10	0.31	0.17	0.13	0.07
2.7	A	0.57	0.39	0.29	0.32	0.57	0.49	0.40	0.23	0.20	0.11	0.13	0.13	0.17	0.23	0.33	0.43
	B	0.18	0.14	0.06	0.09	0.16	0.10	0.11	0.07	0.07	0.03	0.02	0.04	0.05	0.07	0.14	0.13
	C	0.17	0.11	0.05	0.09	0.12	0.12	0.14	0.07	0.05	0.01	0.02	0.03	0.04	0.08	0.15	0.14
	D	0.77	0.42	0.38	0.32	0.59	0.47	0.56	0.35	0.27	0.12	0.15	0.22	0.36	0.56	0.69	0.66
	E	0.25	0.13	0.15	0.12	0.25	0.22	0.24	0.29	0.29	0.12	0.17	0.25	0.48	0.55	0.52	0.26
	F	0.11	0.06	0.05	0.05	0.14	0.12	0.21	0.19	0.29	0.16	0.16	0.26	0.59	0.59	0.35	0.17
	G	0.05	0.02	0.03	0.03	0.07	0.06	0.09	0.10	0.13	0.06	0.07	0.12	0.43	0.31	0.14	0.07
4.7	A	0.38	0.27	0.12	0.05	0.13	0.13	0.15	0.15	0.14	0.06	0.14	0.28	0.27	0.29	0.34	0.24
	B	0.11	0.08	0.03	0.01	0.05	0.06	0.06	0.06	0.03	0.02	0.04	0.06	0.09	0.10	0.12	0.07
	C	0.10	0.06	0.04	0.02	0.04	0.03	0.06	0.04	0.04	0.02	0.02	0.04	0.07	0.08	0.12	0.06
	D	0.40	0.26	0.16	0.08	0.19	0.17	0.30	0.25	0.19	0.10	0.19	0.22	0.55	0.81	0.75	0.34
	E	0.19	0.10	0.05	0.05	0.12	0.15	0.19	0.21	0.23	0.12	0.16	0.28	0.86	0.82	0.57	0.24
	F	0.09	0.04	0.03	0.02	0.06	0.08	0.11	0.18	0.18	0.10	0.12	0.25	0.80	0.91	0.41	0.12
	G	0.02	0.01	0.01	0.01	0.02	0.02	0.05	0.07	0.07	0.02	0.04	0.08	0.44	0.52	0.17	0.03
7.2	A	0.11	0.12	0.06	0.02	0.01	0.02	0.03	0.08	0.06	0.06	0.09	0.26	0.25	0.25	0.30	0.08
	B	0.04	0.04	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.03	0.05	0.06	0.09	0.07	0.04
	C	0.03	0.02	0.02	0.01	0.01	0.00	0.01	0.02	0.03	0.01	0.02	0.06	0.08	0.11	0.07	0.01
	D	0.20	0.12	0.05	0.01	0.05	0.04	0.11	0.17	0.16	0.11	0.16	0.29	0.58	0.92	0.54	0.11
	E	0.14	0.07	0.03	0.02	0.04	0.06	0.12	0.16	0.15	0.09	0.15	0.30	1.32	1.32	0.57	0.12

	F	0.04	0.02	0.01	0.01	0.02	0.02	0.06	0.11	0.10	0.04	0.09	0.17	0.85	0.90	0.31	0.07
	G	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.04	0.05	0.01	0.01	0.06	0.32	0.46	0.09	0.01
9.8	A	0.04	0.04	0.03	0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.07	0.14	0.16	0.15	0.23	0.02
	B	0.02	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.06	0.04	0.05	0.07	0.00
	C	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.04	0.04	0.04	0.05	0.00
	D	0.08	0.07	0.02	0.01	0.01	0.01	0.04	0.09	0.08	0.07	0.18	0.27	0.44	0.79	0.32	0.04
	E	0.07	0.08	0.01	0.01	0.01	0.01	0.06	0.08	0.08	0.08	0.12	0.23	1.08	1.49	0.40	0.04
	F	0.02	0.02	0.00	0.01	0.01	0.01	0.02	0.04	0.04	0.01	0.02	0.07	0.49	0.62	0.13	0.02
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.02	0.11	0.19	0.03	0.00
13.	A	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.13	0.09	0.09	0.19	0.00
	B	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.02	0.03	0.05	0.00
	C	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.02	0.03	0.04	0.00
	D	0.03	0.04	0.01	0.01	0.01	0.00	0.02	0.02	0.04	0.08	0.13	0.26	0.33	0.78	0.38	0.02
	E	0.07	0.10	0.02	0.00	0.01	0.00	0.04	0.04	0.05	0.04	0.10	0.21	0.64	1.63	0.34	0.02
	F	0.02	0.03	0.00	0.00	0.01	0.01	0.02	0.03	0.02	0.00	0.01	0.04	0.23	0.38	0.06	0.01
	G	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.09	0.01	0.00
16.	A	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.04	0.03	0.07	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.02	0.00
	C	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.01	0.02	0.00
	D	0.01	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.04	0.13	0.14	0.09	0.49	0.21	0.01
	E	0.03	0.06	0.01	0.00	0.00	0.00	0.01	0.02	0.01	0.03	0.10	0.14	0.17	0.74	0.18	0.00
	F	0.02	0.03	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.06	0.10	0.01	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00
19.	A	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.01	0.02	0.00
	B	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00
	C	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.01	0.01	0.00
	D	0.02	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.11	0.08	0.14	0.07	0.00
	E	0.02	0.05	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.07	0.06	0.04	0.17	0.05	0.00
	F	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00
	G	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note

a: From Schreckhise, R.G, K. Rhoads, J.S. Davis, B. A. Napier, and J.V. Ramsdell, 1993, *Recommended Dose Calculation Methods and Hanford-Specific Parameters*, PNL-3777, Revision 2, Pacific Northwest Laboratory, Richland, Washington.

The three dams with the largest reservoirs upstream from the Hanford Site are the Mica and Hugh Keenleyside Dams in Canada and the Grand Coulee Dam in the U.S. The controlled flow of the Columbia River caused by these dams results in a lower flood hazard for high-probability floods (e.g., 100-yr floods); however, extremely low probability dam-failure scenarios result in high projected flood flows.

The U.S. Army Corps of Engineers evaluated a number of scenarios on the effects of failures of Grand Coulee Dam, assuming flow conditions on the order of 11,000 m^3/s (400,000 ft^3/s). The discharge resulting from a 50% breach at the outfall of Grand Coulee Dam was determined to be 600,000 m^3/s (21×10^6 ft^3/s). The 50% scenario represents the largest realistically conceivable flow resulting from either a natural or human-induced breach (*Evaluation of Impact of Potential Flooding Criteria on the Hanford Project* [ERDA 1976]). This flood scenario results in a flood level of about 143 m (470 ft) above mean sea level at Columbia River closest to the flood route to the 200 Areas Plateau. The TWRS-P Facility site is greater than 46 m (150 ft) above this flood level and would not be directly affected by this flood.

The Yakima River is approximately 20 km (12.4 mi) south of and greater than 60 m (200 ft) in elevation below the TWRS-P Facility site. Cold Creek and its tributary, Dry Creek, are ephemeral streams in the Yakima River drainage basin (Figure 4-7). The Cold Creek and Dry Creek probable maximum flood (*Flood Risk Analysis of Cold Creek Near the Hanford Site* [Skaggs and Walters 1981]) reaches an elevation of about 195 m (640 ft) on the southwestern portion of the 200 West Area and are separated from the TWRS-P Facility site by a drainage divide exceeding 215 m (705 ft).

The TWRS-P Facility site is a dry site with respect to river flooding. Site run-off is determined using the design basis precipitation presented in Section 4.1.3.2, APrecipitation.@

4.1.4.2 Vadose Zone{tc \l4 "4.1.4.2 Vadose Zone}. The vadose zone in the 200 East Area comprises interlayered gravel, sand, silt, and Amud@ (i.e., silt and clay) and a small area, basalt. Thickness of the vadose zone in the 200 East Area ranges from 37 m (121 ft) near B Pond to 104 m (340 ft) near the southern border of the area (*Hydrologic Setting of the 200 Areas*, in *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993* [DOE-RL 1994]). Fine-grained units in the Hanford formation and the Ringold Formation Lower Mud unit significantly influence the lateral distribution and flux of water in the 200 East Area. The geology of the area and site is discussed in Section 4.1.5, AGeology.@ The vadose zone is about 85 m (280 ft) thick at the TWRS-P Facility site.

Flow rate of water through the vadose zone is a function of the moisture content, matrix potential, and unsaturated hydraulic conductivity for each hydrostratigraphic unit. Water generally flows and spreads laterally at a much greater rate in fine-grained units than in coarse-grained units. Fine-grained units in the vadose zone significantly influence the lateral distribution of water and the flux of water to the uppermost aquifer. Coarse-grained units may impede the flux of water through the vadose zone because of the formation of a capillary pressure barrier between the coarse-grained units and overlying fine-grained units.

Travel time through the vadose zone to the Columbia River is difficult to calculate accurately, even with the most sophisticated available models because of the nonlinear variation of hydraulic conductivity with moisture content. Many simplifying assumptions have been made at the Hanford Site in applying vadose zone models. For these reasons, there is a large amount of uncertainty in travel time calculations for the vadose zone. Previously calculated and modeled travel times through the vadose zone for both nonretarded and retarded species based on recent information on contaminants beneath tanks currently are being addressed.

4.1.4.3 Aquifers{tc \l4 "4.1.4.3 Aquifers}. Two major aquifer systems, the suprabasalt aquifer system and the basalt and interbed aquifer system, lie beneath the Hanford Site (Figure 4-8). The stratigraphy of the 200 East Area is discussed in greater detail in Section 4.1.5, AGeology.@

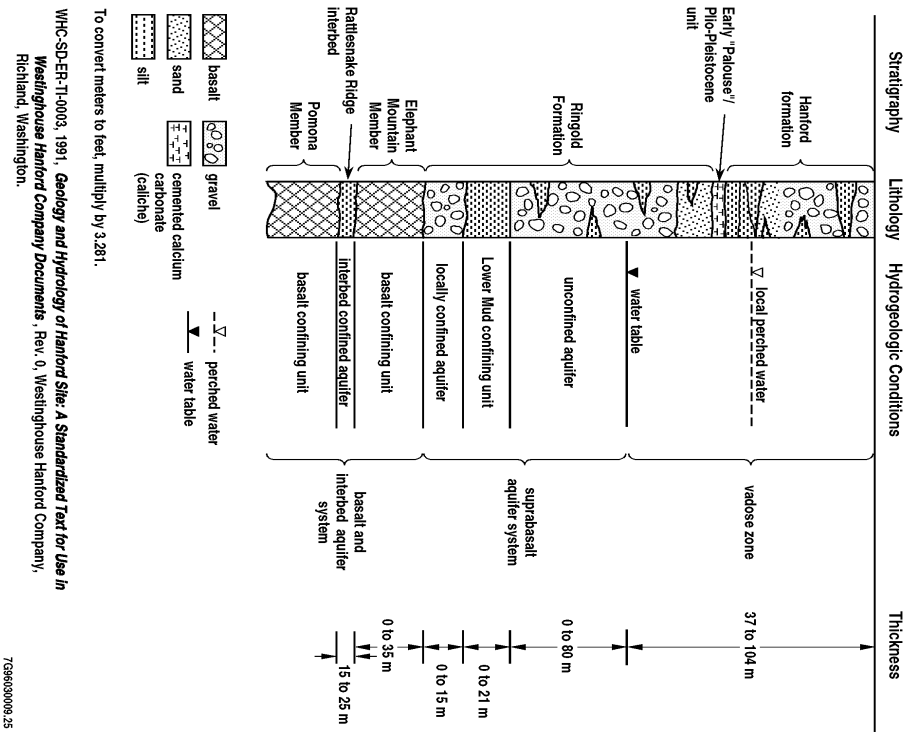
Suprabasalt Aquifer System. The suprabasalt aquifer system at the 200 East Area occurs primarily in the Ringold Formation and Hanford formation stratigraphic segments. The sediment in these segments contains interlayered coarse- and fine-grained units, forming a series of aquifers and aquitards. The depth to the water table under the 200 East Area ranges from less than 40 m (130 ft) near B Pond in the 200 East Area to approximately 104 m (340 ft) west of 200 East Area. At the TWRS-P Facility site, the water table is about 85 m (280 ft) below surface.

The suprabasalt aquifer system at the 200 East Area occurs in the Ringold Formation and parts of the Hanford formation. The suprabasalt aquifer system ranges in thickness from having no thickness where basalt is present above the water table to 60 m (200 ft) in the south and west portions of the 200 East Area.

Basalt and Interbed Aquifer System. The basalt flows and associated sedimentary interbeds form a series of aquifers and aquitards. The dense basalt flows generally form aquitards and interflow zones (fractured basalt zones), and the sedimentary interbeds form aquifers. The uppermost extensive confined aquifer beneath the 200 East and 200 West Areas comprises a single interbed and adjacent interflow zones. The interbed, called the Rattlesnake Ridge interbed, is 15 to 25 m (50 to 84 ft) thick beneath the 200 East and 200 West Areas and generally thickens toward the west (*Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports* [Delaney et. al 1991] and *Hydrology of the Separations Area* [Graham et. al 1981]). Recharge to the Rattlesnake Ridge interbed aquifer occurs in the higher elevations to the west, north, and northeast of the 200 East and 200 West Areas. Groundwater generally flows toward the west to west-northwest beneath the 200 East Area and toward the northeast beneath the 200 West Area.

4.1.5 Geology{tc \l3 "4.1.5 Geology}

The Hanford Site lies within the Columbia Plateau, which consists of a thick sequence of tholeiitic basalt flows called the Columbia River Basalt Group (CRBG). These flows have been folded and faulted over the past 17 million years, creating broad structural and topographic basins separated by asymmetric anticlinal ridges. Sediments up to 518 m (1700 ft) in thickness have accumulated in some of these basins. Basalt flows of the CRBG are exposed along the



Stratigraphy
Lithology
Hydrogeologic Conditions
Thickness
Hanford formation
Early "Palouse"/ Plio-Pleistocene unit
Ringold Formation
Elephant Mountain Member
Rattlesnake Ridge interbed
Pomona Member
local perched water
water table
unconfined aquifer
Lower Mud confining unit
locally confined aquifer
basalt confining unit
interbed confined aquifer
basalt confining unit
vadose zone
suprabasalt aquifer system
basalt and interbed aquifer system
37 to 104 m
0 to 80 m
0 to 21 m
0 to 15 m
0 to 35 m
15 to 25 m
basalt
sand
silt
gravel
cemented calcium carbonate (caliche)
perched water
water table
To convert meters to feet, multiply by 3.281.
WHC-SD-ER-TI-0003, 1991, *Geology and Hydrology of Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
7G96030009.25
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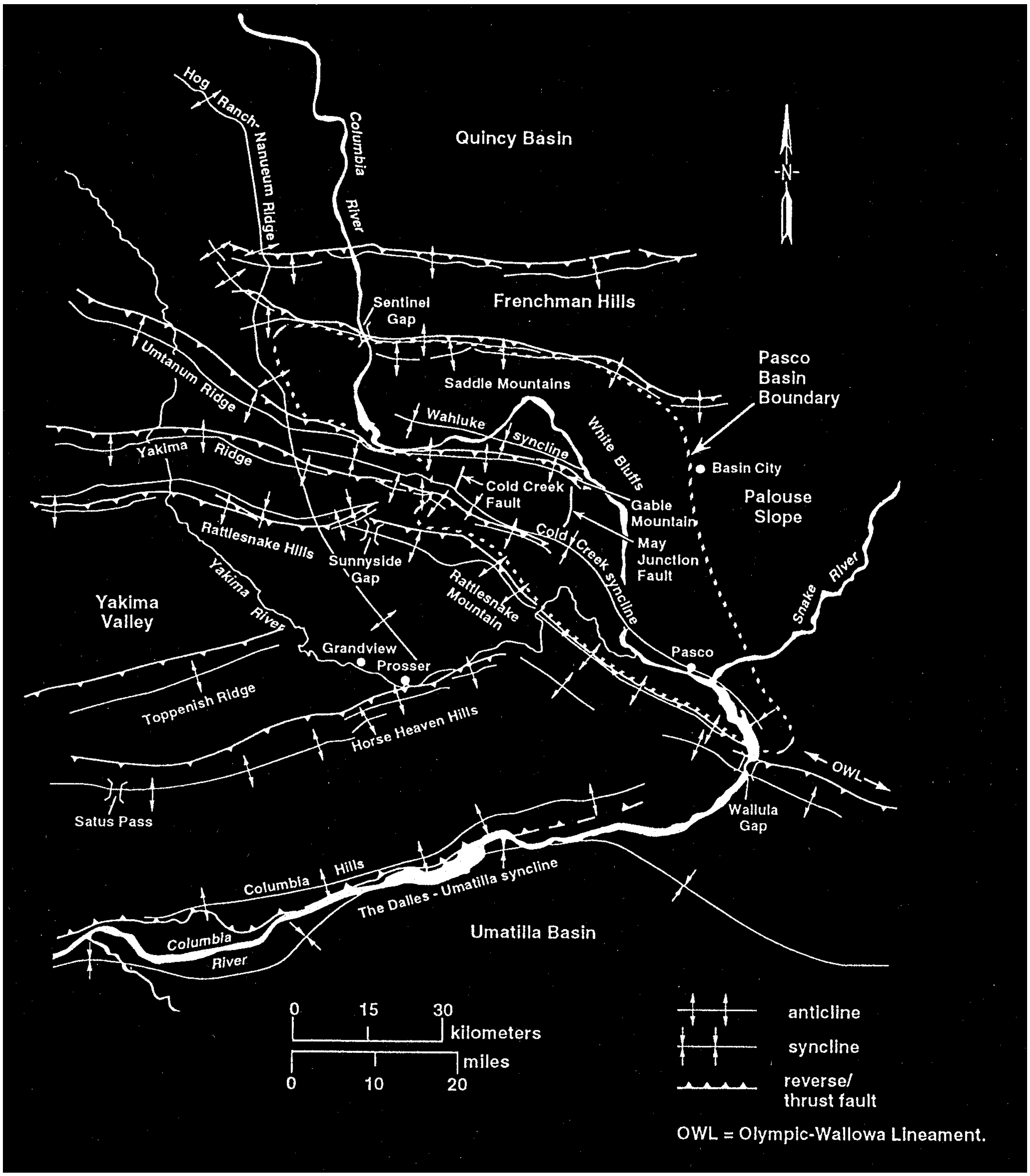
anticlinal ridges, where they have been uplifted as much as 1,097 m (3,600 ft) above the surrounding area. Overlying the CRBG in the synclinal basins are sediments of the late Miocene, Pliocene, and Pleistocene age. The Hanford Site lies within one of the larger basins, the Pasco Basin. The Pasco Basin is bounded on the north by the Saddle Mountains and on the south by Rattlesnake Mountain and the Rattlesnake Hills (Figure 4-9). Yakima Ridge and Umtanum Ridge trend into the basin and subdivide it into a series of anticlinal ridges and synclinal basins. The largest syncline, the Cold Creek syncline, lies between Umtanum Ridge and Yakima Ridge and is the principal structure containing the DOE waste management areas and the TWRS-P Facility site. The geology of the Hanford Site and surrounding area are described in detail in Volume 1 of *Site Characterization Plan Reference Repository Location, Hanford Site, Washington* (DOE 1988).

The 200 Areas lie on the Cold Creek bar, a geomorphic remnant of the cataclysmic floods of the Pleistocene. As the flood water raced across the lowlands of the Pasco Basin and Hanford Site, it lost energy and began leaving behind deposits of sand and gravel. The 200 Areas Plateau is one of the most prominent deposits. The Plateau lies just south of one of the major channelways across the Site that forms the topographic lowland south of Gable Mountain.

Borehole data provide the principal source of geologic, hydrologic, and groundwater information for the 200 East Area and the TWRS-P Facility site (Figure 4-10). Numerous boreholes (both vadose zone boreholes and groundwater monitoring wells) have been drilled in the 200 East Area for groundwater monitoring and waste management studies. However, data are limited within the TWRS-P Facility site; only one characterization borehole (2-E25-234) (Figure 4-11) was drilled, and it did not penetrate the entire sediment stratigraphic section. Further, this borehole begins about 15 m (50 ft) below grade. Most boreholes in the 200 East Area have been drilled using the cable tool method. Some boreholes were drilled with rotary and wire-line coring methods. Geologic logs based on these boreholes are constructed from examination of chips and cuttings which limits information on all but the broadest of all stratigraphic units. Chip samples, routinely archived at the Hanford Geotechnical Sample Library, typically are taken at 1.5-m (5-ft) intervals.

4.1.5.1 Stratigraphic Setting of the Hanford Site. Figure 4-12 shows the main stratigraphic units at the Hanford Site, in ascending order, the CRBG (Miocene), the Ringold Formation (Miocene-Pliocene), and the Hanford formation (Pleistocene). A regionally discontinuous veneer of recent alluvium, colluvium, and/or eolian sediments overlies the principal stratigraphic units.

Ringold Formation. The Ringold Formation of the Neogene age is composed of weakly to moderately consolidated and compacted fluvial coarse-grained gravels and sands as well as fine-grained muds associated with lacustrine and fluvial overbank environments (Figure 4-13). These strata record a history of alluvial-lacustrine sedimentation and pedogenic activity associated with the ancestral Columbia River system (APaleodrainage of the Columbia River System on the Columbia Plateau of Washington State **C** A Summary," in *Selected Papers on the Geology of Washington@* [Fecht et. al 1987]). Ringold deposits overlie basalts and are overlain by late Pliocene- and Pleistocene-aged deposits.


Quincy Basin
Columbia River
Hog Ranch-Nanueum Ridge
Frenchman Hills
Sentinel Gap
Saddle Mountains
Pasco Basin Boundary
Umtanum Ridge
Wahluke syncline
White Bluffs
Basin City
Yakima Ridge
Cold Creek Fault
Gable Mountain
Palouse Slope
May Junction Fault
Cold Creek syncline
Rattlesnake Hills
Sunnyside Gap
Rattlesnake Mountain
Yakima Valley
Yakima River
Snake River
Grandview
Prosser
Pasco
Toppenish Ridge
Horse Heaven Hills
OWL
Wallula Gap
Satus Pass
Columbia Hills
The Dalles - Umatilla syncline
Umatilla Basin
Columbia River
0 15 30 kilometers
0 10 20 miles
anticline
syncline
reverse/ thrust fault
OWL = Olympic-Wallowa Lineament.
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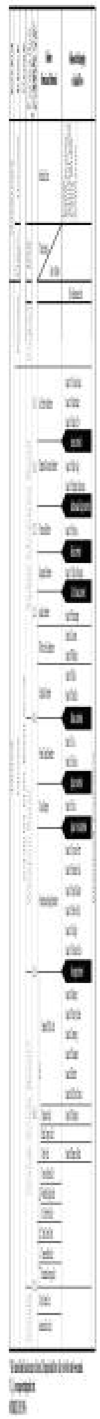

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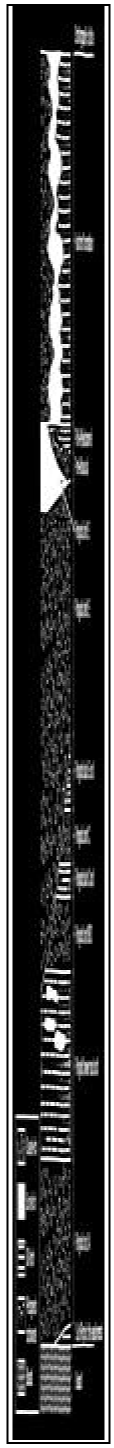
TWRS-P PROJECT
INITIAL SAFETY ANALYSIS REPORT
BNFL-5193-ISAR-01, REV. 0



January 12, 1998

The Ringold Formation at the Hanford Site represents deposits of the ancestral Columbia and Snake Rivers between 8 and 3 million years ago. The depositional system was a braided stream channel with the two rivers joining in eastward shift of the Columbia River from the west side of the Site. The Columbia River first flowed across the west side and up Dry Creek, crossing over the Rattlesnake Hills at Sunnyside Gap. The river eventually shifted to a course that took it through Gable Gap and south across the present 200 East Area.

Traditionally, the Ringold Formation in the Pasco Basin and Hanford Site has been divided into several informal units: (1) gravel, sand, and paleosols of the basal unit; (2) clay and silt of the lower unit; (3) sand and gravel of the middle unit; (4) mud and lesser sand of the upper unit; and (5) basaltic detritus of the fanglomerate unit (DOE 1988). Ringold strata also have been divided on the basis of facies types and fining upwards sequences (*Suprabasalt Sediments of the Cold Creek Syncline Area*, [Tallman et. al 1981]; A*Geology of the Northern Part of the Hanford Site: An Outline of Data Sources and the Geologic Setting of the 100 Areas*@ [Lindsey 1992]).

Most of the area beneath the TWRS-P Facility site is composed of a single coarse-grained fluvial sequence belonging to unit A of the Ringold Formation. The upper surface of unit A is relatively flat to the north but dips southward beneath the southern portion of the TWRS-P Facility site. The relatively flat northern portion of unit A was probably truncated and beveled off during Pleistocene cataclysmic flooding, that eroded more to the north of the TWRS-P Facility site (Lindberg et. al 1993). Often it is difficult to distinguish the unit A of the Ringold Formation from the overlying lower gravel sequence of the Hanford formation because of their similar coarse-grained textures.

The fine-grained overbank and lacustrine deposits of the lower mud unit are not present beneath most of the TWRS-P Facility site but do appear to be present along the eastern edge of the site over to B-Pond as well as to the south of the site. The lower mud unit is significant hydrologically because it may act as a confining layer that influences the movement of groundwater in the area. However, the lower mud unit is not present directly beneath the TWRS-P Facility site, so it should not affect the groundwater flow system in this area. In the vicinity of the TWRS-P Facility site, cataclysmic floods eroded into the Ringold Formation and blanketed the area with mostly coarse-grained, loosely consolidated deposits of the Hanford formation.

Hanford Formation. The Hanford formation is an informal name that represents all the deposits of the cataclysmic floods of the Pleistocene (2 Ma to 13 ka [2 million to 13,000 yrs ago]). Glacial Lake Missoula and other smaller lakes formed in the Clark Fork River Valley and other river valleys behind continental glaciers that spread south as far as the northern part of the Columbia Plateau. Glacial Lake Missoula was impounded behind ice dams that failed many times, allowing the impounded water to spread across eastern Washington and form the Channeled Scablands. These flood waters collected in the Pasco Basin and formed Lake Lewis, which slowly drained through the small water gap in the Horse Heaven Hills called Wallula Gap. Evidence has been found for at least four major cataclysmic flood sequences in and around the Hanford Site, the last ending approximately 13 ka. Three principal types of deposits were left behind by the floods: (1) high-energy, coarse-grained facies; (2) low-energy slackwater rhythmite facies consisting of rhythmically bedded silt and sand of the Touchet Beds; and (3) plane-laminated sand facies representing an energy transition environment.

The Hanford formation typically has been divided into a variety of sediment types, facies, or lithologic packages. Recent reports dealing with the Hanford formation (*Revised Stratigraphy for* *the Ringold Formation, Hanford Site, South-Central Washington* [Lindsey 1991a] and *Field Trip Guide to the Hanford Site* [Reidel et. al 1992]) have recognized three basic facies: (1) gravel-dominated, (2) sand-dominated, and (3) silt-dominated. These facies generally correspond to the coarse gravels, laminated sands, and graded rhythmites, respectively. The Hanford formation thickens from as little as 30 m (100 ft) in the 200 West Area to more than 100 m (330 ft) in the 200 East Area. The Hanford formation is about 90 m (295 ft) thick at the TWRS-P Facility site.

The gravel-dominated facies consist of coarse-grained sand and granule-to-boulder gravel that displays massive bedding, plane to low-angle bedding, and large-scale cross-bedding in outcrop. A matrix is commonly lacking from the gravels, giving them an open-framework appearance. The sand-dominated facies consists of fine- to coarse-grained sand and granules that display plane lamination and bedding and, less commonly, plane and trough cross-bedding in outcrop. Small pebbles and pebbly interbeds (<20 cm [8 in.] thick) may be encountered. The silt content of these sands varies, although where its content is low, an open-framework texture may occur. The silt-dominated facies consists of silt and fine- to coarse-grained sand forming normally graded rhythmites. Plane lamination and ripple cross-lamination is common in outcrop.

Holocene Surficial Deposits. Holocene surficial deposits consisting of silt, sand, and gravel form a thin (<5 m [<16 ft]) veneer across much of the Hanford Site. In the 200 West Area and the southern part of the 200 East Area, these deposits consist dominantly of laterally discontinuous sheets of wind-blown silt and fine-grained sand.

Much of the TWRS-P Facility site has been excavated and cleared of vegetation. Only parts of the northern and eastern portions are undisturbed. Across most of the area, the Holocene sediments are at most a few meters thick. These are primarily stabilized eolian deposits.

Basalt Bedrock. The Elephant Mountain Basalt forms the bedrock beneath the TWRS-P Facility site. It dips to the south from 105 m (345 ft) elevation above mean sea level at the north end of the site to 75 m (246 ft) above mean sea level at the south end. The post-basalt stratigraphy for the TWRS-P Facility site is shown in Figure 4-12. Approximately 100 to 125 m (328 to 410 ft) of suprabasalt sediments overlie the basalt bedrock at the TWRS-P Facility site.

4.1.5.2 Tectonic Setting of the Hanford Site{tc \l4 "4.1.5.2 Tectonic Setting of the Hanford Site}. This section describes the structure and seismicity of the Hanford Site.

Structure. The geologic structure of the Pacific Northwest is controlled by a basement rock assemblage of accreted terrains fused onto the structurally complex North American craton from the early Mesozoic to early Cenozoic Eras. The accreted terrains form the backbone of the Cascade Range, Okanogan Highlands, and the Blue Mountains. The terrains are now extensively covered by Cenozoic Era rocks that were folded and faulted in a north-south-oriented compressive regime. North-south compression is continuing in the Pacific Northwest east of the Cascades. This pattern of Cenozoic Era deformation is expected to continue into the future.

The Columbia Basin is a structurally and topographically low area surrounded by mountains ranging in age from the late Mesozoic Era to Recent Epoch. The Columbia Basin has two major structural subdivisions or subprovinces: the Yakima Fold Belt (YFB) and the Palouse Slope. The Palouse Slope is noted in Figure 4-9. The YFB is a series of anticlinal ridges and synclinal valleys in the western and central Columbia Basin. In Figure 4-9, the YFB includes those anticlines and synclines west of the Pasco Basin boundary. The Hanford Site is in the east part of the YFB. The Palouse Slope forms the eastern part of the Columbia Basin and is mainly a westward-tilting paleoslope. The west boundary of the Palouse Slope is at the east boundary of the Hanford Site.

Three major structural features cross-cut the Columbia Basin and influence the geology of the Hanford Site. These are the Olympic-Wallowa lineament, the Hog Ranch-Naneum Ridge anticline, and the YFB. The Olympic-Wallowa lineament passes along the southern boundary of the Hanford Site and the Hog Ranch-Naneum Ridge anticline forms the western structural boundary of the Pasco Basin. A map of these major structural features of the YFB is shown in Figure 4-9.

The Cold Creek syncline, shown in Figure 4-9 between the Umtanum Ridge-Gable Mountain uplift and the Yakima Ridge uplift, is an asymmetric and relatively flat-bottomed structure. The 200 East and 200 West Areas lie on the northern flank of the Cold Creek syncline where the bedrock dips approximately 5E to the south. The 300 Area lies at the east end of the Cold Creek syncline where it merges with the Pasco Basin syncline.

The Umtanum Ridge-Gable Mountain structural trend is a segmented anticlinal ridge extending for a length of 110 km (68 mi) in an east-west direction and passes north of the 200 East, 200 West, and 300 Areas and south of the 100 Areas. The Umtanum Ridge plunges from west to east and joins the Gable Mountain-Gable Butte segment just east of the west boundary of the Hanford Site. The easternmost segment of the Umtanum Ridge, the Southeast anticline, trends southeast off the east boundary of the Gable Mountain-Gable Butte segment.

The 200 East, 200 West, and 300 Areas are situated on the south flank of the Umtanum Ridge-Gable Mountain anticline where the Miocene-aged basalt bedrock dips to the southwest into the Cold Creek syncline. The 100 Areas lie north of the Umtanum Ridge-Gable Mountain anticline in the Wahluke syncline. The deepest parts of the Cold Creek syncline, the Wye Barricade depression, and the Cold Creek depression are approximately 12 km (8 mi) southeast of the 200 East and 200 West Areas. The Cold Creek syncline and Cold Creek depression are under the 200 West Area.

The pattern of deformation in the Columbia Basin has been dominated by north-south compression and subsidence that began in the early Tertiary Period before the eruption of the CRBG and continues today. The YFB is the principal product of the compression and subsidence. This deformation has controlled the location of the Columbia River system since the late Miocene Epoch and also has controlled the depositional pattern of the post-basalt sediments.

The rates of deformation, both regional subsidence and rate of local uplift, in the Columbia Basin have declined since the early Tertiary Period. The present rate of subsidence in the basin is estimated at 3.0×10^{-3} mm/yr (1.0×10^{-4} in./yr) and the rate of ridge growth is estimated at 0.05 mm/yr (0.002 in./yr).

Microseismicity (i.e., high in situ stress conditions) and the geometry of Quaternary-Holocene Epoch faulting indicate that the Columbia Basin still is experiencing north-south compression. Although known late Cenozoic faults are found exclusively on the anticlinal ridges, earthquake focal mechanisms and strain measurements suggest that most stress release is occurring in the synclinal areas. The high in situ stress in the Cold Creek syncline explains the microseismicity in the region, but the absence of microseismicity associated with the anticlinal ridges may result from weakened fault zones, lubricated with groundwater, that have a component of a seismic or below-detection limit seismic slip, or the fault zones may be locked up.

Seismicity. Seismic monitoring at the Hanford Site began in the summer of 1969 when the U.S. Geological Survey installed a small array of seismograph stations around the Site. A closely spaced seismic network was installed at the Site in 1982 to characterize Site microseismicity for a possible high-level waste repository. The complete network operated until 1988 when the number of stations in the network was reduced. Earthquakes of magnitudes 1.0 (coda amplitude magnitude) can be recorded and located at the Hanford Site. Earthquakes of magnitude 2.5 and larger are detected and located throughout most of eastern Washington State.

Earthquakes at the Hanford Site can be related to three crustal layers and five general sources (see Tables 4-11 and 4-12). The three horizontal layers of stratigraphy related to seismicity at the Hanford Site and vicinity are the CRBG, the prebasalt sediments, and the crystalline basement (see Table 4-11). About 75% of Site earthquake events originate in the CRBG layer. The prebasalt sedimentary layer has been the origin of 8% of the events and the crystalline basement has been the origin of 17% of these events. All layers and sources are monitored at the Hanford Site except the Cascadia Subduction Zone source, which is monitored at the University of Washington Seattle campus.

Table 4-11. Three Crustal Layers Related to Earthquakes at the Hanford Site

Layer	Depth	
	km	mi
Columbia River Basalt Group	0-5	0-3
Prebasalt sediments	10	6
Crystalline basement	>10	>6

Table 4-12. Five General Sources of Earthquakes at the Hanford Site

Area	Layer
Major reverse faults on ridges	Mainly basalt, also prebasalt sediments
Secondary faults on ridges	Basalt
Swarm area	Basalt
Basement	Crystalline basement
Cascadia Subduction Zone	Lithosphere - plate tectonic boundary

There are five different tectonic environments (i.e., earthquake sources) where earthquakes can occur at the Hanford Site as follows (see Table 4-12):

1) Reverse and thrust faults in the CRBG associated with major anticlinal ridges (e.g., Rattlesnake Mountain, Yakima Ridge, and Umtanum Ridge)

2) Secondary faults occurring on the major anticlinal ridges

3) Small geographic areas of unknown geologic structure that produce clusters of events, called swarms, usually in the CRBG in synclinal valleys

4) Basement source structures

5) The Cascadia Subduction Zone.

Little is known about geologic structures in the crystalline basement beneath the Hanford Site, therefore, earthquakes cannot be directly tied to a mapped fault or other basement structure. The Cascadia Subduction Zone recently has been postulated to be capable of producing a magnitude 9.0 earthquake (*Probabilistic Seismic Hazard Analysis, DOE Hanford Site Washington* [Geomatrix 1996]).

4.1.5.3 Geologic Hazards. The geologic hazards that affect the performance of TWRS-P Facility activities have been assessed on the basis of the geologic data addressed in previous sections. These hazards are discussed below and, where appropriate, are quantified for use in the structural evaluations and safety analyses for the TWRS-P Facility.

Seismic Hazard. A seismic hazard analysis recently was completed for the DOE-controlled areas on the Hanford Site (Geomatrix 1996). *Seismic Exposure for the WNP-2 and WNP-1/4 Site* (Power et. al 1981), documents a previous Site seismic hazard analysis performed for the Washington Public Power Supply System. Application of the analysis findings to the DOE-controlled areas on the Hanford Site is documented in *Evaluation of Seismic Hazard for Nonreactor Facilities, Hanford Reservation, Hanford, Washington* (Woodward-Clyde Consultants 1989).

Geomatrix (1996) incorporates seismo-tectonic data and interpretations that postdate the Power et. al (1981) and (Woodward-Clyde Consultants 1989) assessments. Potential seismic crustal sources determined to be major contributors to the seismic hazard in and around the Hanford Site are as follows:

1) Fault sources related to the YFB

2) Shallow basalt sources that account for the observed seismicity in the CRBG and not associated with the anticlines

3) Crystalline basement source region.

The mean seismic hazard curve for the 200 East Area is shown in Figure 4-14. Figure 4-15 illustrates contributions of individual YFB folds to the mean seismic hazard at the 200 East Area.

The Site response characteristics of the soils underlying the 200 East and 200 West Areas are similar to those represented in the California empirical strong motion database (Geomatrix 1996). This similarity was determined by comparing the relative response of characteristic Hanford Site soil profiles and dynamic soil properties with those of California deep soil strong-motion recording stations. Time histories representative of the events contributing to the Hanford Site hazard were used for ground motion input.

Response spectra for the 200 East Area of the Hanford Site were developed using the procedure outlined in *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities,* DOE-STD-1020-94, (DOE 1994c) and *Natural Phenomena Hazards Assessment Criteria*, DOE-STD-1023-94, (DOE 1994b). The mean magnitude and distance for the major contributors to the hazard were determined using the results of the probabilistic hazard study. Median spectral shapes were computed by developing median response spectra using the average of the attenuation models for crustal events used in the draft seismic hazard study. The spectral shapes were computed for the source-type that dominates the hazard at specified periods (frequencies). The enveloping shape of these @deterministic@ response spectra was similar to the equal-hazard response spectra developed from the seismic hazard assessment.

Further, the equal-hazard response spectral shape for the TWRS-P Facility design basis earthquake (DBE), Figure 4-16, is similar to the Newmark and Hall (1978) spectra as shown in Figure 4-17. The differences are that there is slightly more amplification in the high frequency (<0.3 sec) and less amplification in the lower frequencies (>0.3 sec) of the equal-hazards response spectra. These differences are expected because the Hanford Site is an area of relatively near-field moderate-to low-magnitude compared to the database used in for the Newmark and Hall spectral shapes.

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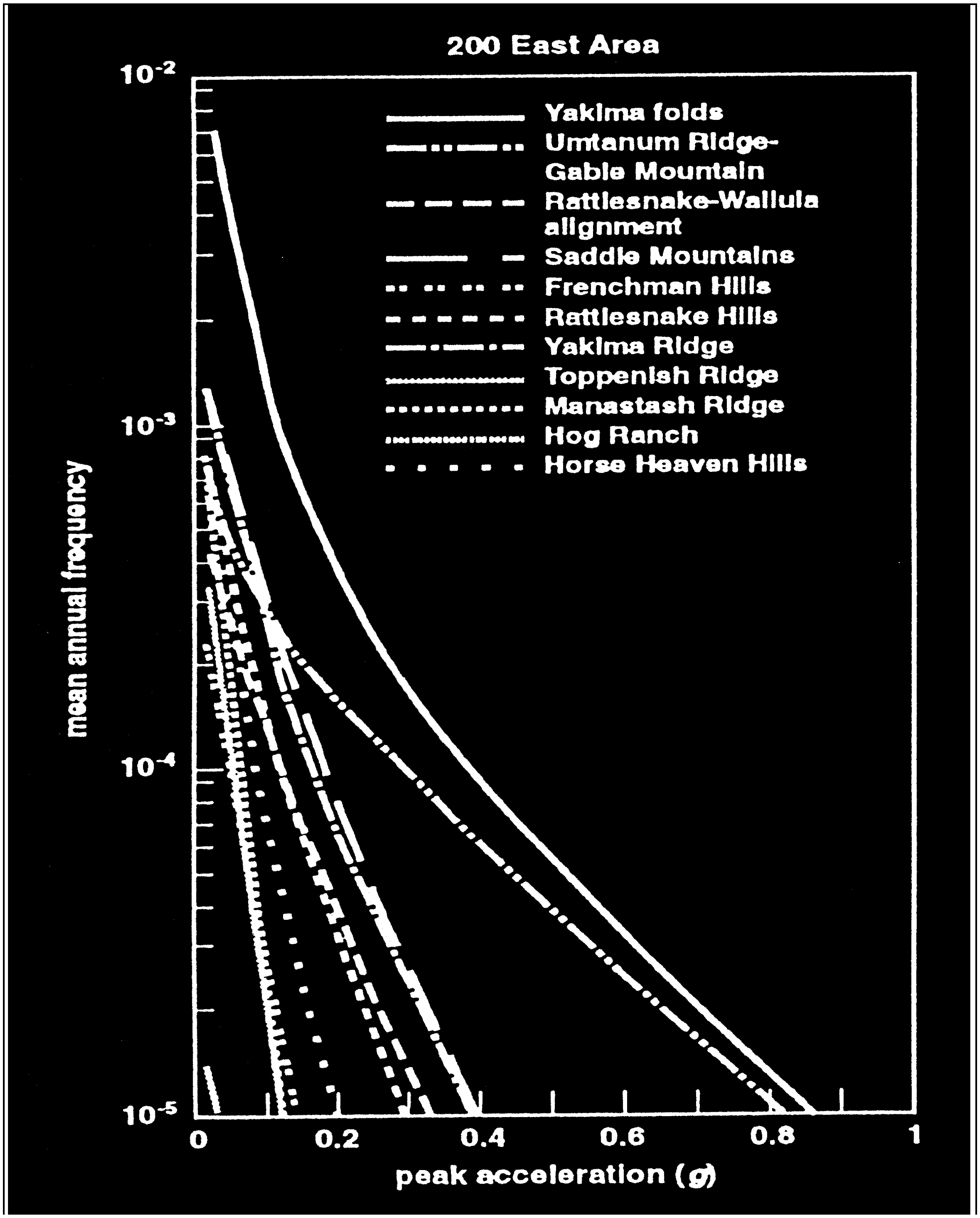
200 East Area
Yakima folds
Umtanum Ridge-Gable Mountain
Rattlesnake-Wallula alignment
Saddle Mountains
Frenchman Hills
Rattlesnake Hills
Yakima Ridge
Toppenish Ridge
Manastash Ridge
Hog Ranch
Horse Heaven Hills
mean annual frequency
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0
0.2
0.4
0.6
0.8
1
peak acceleration (g)

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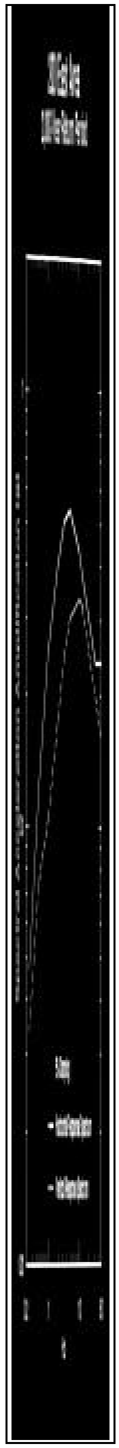

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Historical earthquakes were also compared to the Design Basis Earthquake as recommended in *Natural Phenomena Hazards Assessment Criteria*, DOE-STD-1023-94, (DOE 1994b). The largest historical earthquake felt at the Hanford Site is a magnitude 5.7 in Milton Freewater, Oregon, about 90 km (56 mi) from the site. The peak ground acceleration at the site was < 0.05 G.

The equal-hazard response spectral shapes are adopted for the TWRS-P Facility DBE because they most accurately represent the seismic hazard for SSCs with NPH safety functions. The response spectra are the 2,000-yr return period equal-hazard spectra, the horizontal spectrum anchored at 0.24 G. These response spectra meet the requirements for a Performance Category 3 of *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE-STD-1020-94, (DOE 1994b). In addition, they are 20% higher than the UBC peak ground acceleration for the Hanford Site. SSCs without NPH safety functions are designed to UBC, Zone 2B (ICBO 1994).

Volcanic Hazard Assessment. Two types of volcanic hazards have affected the Hanford Site in the past 20 million years. The hazards were (1) continental flood basalt volcanism that produced the CRBG, and (2) volcanism associated with the Cascade Range. Several volcanoes in the Cascade Range currently are considered to be active, but activity associated with flood basalt volcanism has ceased.

The flood basalt volcanism that produced the CRBG occurred between 17 and 6 million years ago. Most of the lava was extruded during the first 2 to 2.5 million years of the 11-million-year volcanic episode. Volcanic activity has not recurred during the last 6 million years, suggesting that the tectonic processes that created the episode have ceased. The recurrence of CRBG volcanism is not considered to be a credible volcanic hazard (DOE 1988).

Volcanism in the Cascade Range was active throughout the Pleistocene Epoch and has remained active through the Holocene Epoch. The eruption history of the current Holocene Epoch best characterizes the most likely types of activity in the next 100 years. Many of the volcanoes have been active in the last 10,000 years, including Mount Mazama (Crater Lake) and Mount Hood in Oregon; and Mount Saint Helens, Mount Adams, and Mount Rainier in Washington (see Figures 4-18 and 4-19). The Hanford Site is approximately 150 km (93 mi) from Mount Adams, 175 km (109 mi) from Mount Rainier, and 200 km (124 mi) from Mount Saint Helens, the three closest active volcanoes. At these distances, the tephra (ash) is the only hazard. Mount Saint Helens has been considerably more active throughout the Holocene Epoch than Mount Rainier or Mount Adams (the least active of the three).

Probabilistic volcanic hazard studies of the Cascade Range have been completed by the U.S. Geological Survey (*Volcanic Hazards with Regards to Siting Nuclear-Power Plants in the Pacific Northwest*, [Hoblitt et. al 1987] and *Volcanic Hazards in the Mount Adams Region, Washington* [Scott et al. 1995]). Figure 4-18 illustrates the annual probability of exceeding 10 mm (0.4 in.) of volcanic ash accumulation in Washington and Oregon following the eruption of a major Cascade Range volcano and Figure 4-19 illustrates the annual probability of exceeding 100 mm (4 in.) of volcanic ash accumulation. Figure 4-20 presents a volcanic ash hazard curve for the Cascade Range, which is applicable to the Hanford Site.

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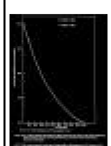

A study was performed to develop ashfall hazard annual probabilities for use in design and evaluation at the Hanford Site (Salmon 1996). This study followed the same methods as were used to determine the hazard probabilities for other hazard, for example seismic. This was necessary because *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities,* DOE-STD-1020-94, (DOE 1994b) did not address ash hazard. The ground ash load for SSCs with NPH safety functions is 61 kg/m^2 (12.5 lbm/ft^2) and for SSCs without NPH safety function, 24 kg/m^2 (5.0 lbm/ft^2).

Subsurface Stability. The 200 Areas Plateau is a large flood bar formed by cataclysmic flooding during the Pleistocene Epoch. The foundation material is predominantly the sand-dominated facies of the Hanford formation with varying amounts of gravel. The backfill used at the tank farm sites consists of native soil that has been compacted. Though the 200 Areas Plateau soils have the same genesis, variations in the depositional energy results in textural variation across the plateau. The static and dynamic properties of the plateau soils are quite similar, but the specific characteristics at each tank farm must be evaluated for certain analyses.

The field and laboratory studies that have been completed at many of the tank farm sites are summarized in *Bibliography and Summary of Geotechnical Studies at the Hanford Site* (Giller 1992). These studies reveal that there are no areas of potential surface or subsurface subsidence, uplift, or collapse at the Site, with the minor exceptions of the Cold Creek and Wye Barricade depressions discussed previously. With the exception of the loose superficial wind-deposited silt and sand in some locations, the in-place soils are competent and form good foundations.

Liquefaction is the sudden decrease of shearing resistance of a cohesionless soil, caused by the collapse of the structure by shock or strain, and is associated with a sudden but temporary increase of the pore fluid pressure. Saturated or near-saturated soil (sediments) are required for liquefaction to occur. Therefore, liquefaction of soils beneath the site is not a credible hazard because the water table is greater than 80 m (260 ft) below ground surface.

Geotechnical investigations were completed near the TWRS-P Facility site as part of the Grout Treatment Facility siting (*Geotechnical and Corrosion Investigation Grout Vaults* [Dames & Moore 1988]). One characterization borehole was drilled and measurements, including shear-wave velocities, were made. However, this borehole began in an excavation about 15 m (50 ft) below ground surface. Six very shallow boreholes (about 5 m [16 ft] deep) were drilled in the general area of the TWRS-P Facility site but they were not subjected to dynamic testing.

4.1.6 Natural Phenomena Design Requirements{tc \l3 "4.1.6 Natural Phenomena Design Requirements}

Tables 4-13 and 4-14 summarize the natural phenomena design requirements for SSCs with and without NPH safety functions.

Table 4-13. Natural Phenomena Design Loads for SSCs With NPH Safety Functions

Hazard	Load	Application documents
Seismic	Equal-hazards response spectra[a] 0.24 g horizontal, @ 33 hz 0.16 g vertical, @ 50 hz See Figure 4-16	DOE-STD-1020-94[b]
Straight wind	42 m/s (95 mi/hr), 3-second gust, at 10 m (33 ft) above ground, Importance factor, I=1.0	ASCE-7-95[c] DOE-STD-1020-94[b]
Wind Missile	5 cm x 10 cm (2 x4 in.) timber plank, 6.8 Kg (15 lb) at 22 m/s (50 mi/h) (horiz), Max. height 9 m (30 ft)	DOE-STD-1020-94[b]
Tornado and Tornado Missiles	Not Applicable	DOE-STD-1020-94[b]
Volcanic ash	61 kg/m^2 (12.5 lbm/ft^2) ground ash load[d]	DOE-STD-1020-94[b]
Flooding	Dry site for river flooding Site drainage: 10 cm (3.9 in.) for 6-hr precipitation	DOE-STD-1020-94[b]
Snow	75 kg/m^2 (15.4 lbm/ft^2) ground load	ASCE-7-95[c]

a From Geomatrix, 1996, *Probablistic Seismic Hazard Analysis DOE Hanford Site, Washington*, WHC-SD-W236A-TI-002, Rev. 1, prepared by Geomatrix Consultants, Incorporated, San Francisco, California, for Westinghouse Hanford Company, Richland, Washington.

b From *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE-STD-1020-94, U.S. Department of Energy, Washington, D.C.

c From ASCE, 1995, *Minimum Design Loads for Building and Other Structures*, ASCE-7-95, American Society of Civil Engineers, New York, New York.

d From Tallman 1996,*Natural Phenomena Hazards, Hanford Site, South-Central Washington*, WHC-SD-GN-ER-501, Rev. 0, Westinghouse Hanford Company.

4.1.7 Nearby Facilities and Transportation{tc \l3 "4.1.7 Nearby Facilities and Transportation}

The presence of nearby DOE and industry facilities and transportation and the hazards they may present to the TWRS-P Facility are discussed in Section 2.1.3, ANearby Facilities and Transportation@ of the TWRS-P Facility Hazard Analysis Report (BNFL 1997d). In Part B this information will be relocated to the Safety Analysis Reports.

4.2 FACILITY DESCRIPTION{tc \l2 "4.2 FACILITY DESCRIPTION}

This section provides descriptions of the TWRS-P Facility buildings and their content, the civil/structural design criteria and methodology applied to the design of the buildings and piping systems, and the constructability program.

Table 4-14. Natural Phenomena Design Loads for SSCs Without NPH Safety Functions

Hazard	Load	Application documents
Seismic	Uniform Building Code, Zone 2B[a] Importance factor, I=1.0	DOE-STD-1020-94[b] Uniform Building Code, Essential Facilities
Straight wind	38 m/s (85 mi/hr) 3-second gust, at 10 m (33 ft) above ground, Importance factor, I=1.07	ASCE-7-95[c] DOE-STD-1020-94[b]
Wind Missile	Not Applicable	DOE-STD-1020-94[b]
Tornado and Tornado Missiles	Not Applicable	DOE-STD-1020-94[b]
Volcanic ash	24 kg/m^2 (5.0 lbm/ft^2) ground ash load[d]	DOE-STD-1020-94[b]
Flooding	Dry site for river flooding Site drainage: 6.4 cm (2.5 in.) for 6-hr precipitation	DOE-STD-1020-94[b]
Snow	75 kg/m^2 (15.4 lbm/ft^2) ground load	ASCE-7-95[c]

a From *Uniform Building Code*, International Conference of Building Officials, Whitter, California.
b From *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE-STD-1020-94, U.S. Department of Energy, Washington, D.C.
c From ASCE, 1995, *Minimum Design Loads for Building and Other Structures*, ASCE-7-95, American Society of Civil Engineers, New York, New York.
d From Tallman 1996,*Natural Phenomena Hazards, Hanford Site, South-Central Washington*, WHC-SD-GN-ER-501, Rev. 0, Westinghouse Hanford Company.

4.2.1 Building Descriptions{tc \l3 "4.2.1 Building Descriptions}

The TWRS-P Facility for treating both the low activity waste (LAW)-Only option and the high-level waste (HLW)/LAW option includes the following major structures:

1) Process building
2) Wet chemical store
3) Glass formers store
4) Melter assembly building
5) Empty canister store
6) Services buildings
7) Administration building.

Structures associated with the operation of the double shell tank (DST) 241-AP-106 include the following:

1) Tank 241-AP-106 service building
2) Central pump pit/transfer pump pit enclosure building
3) Transfer pump pit.

Buildings that are important to the ISA because they house the primary process cells or provide for transfer or storage of hazardous and radiological materials are the process building, wet chemical store, glass formers store, tank 241-AP-106 service building, central pump pit/transfer pump pit enclosure building, and the transfer pump pit.

Figure 1-1 shows the locations of the buildings and the facility fence. A minimum setback of 15 m (50 ft) from the fence is provided for all structures. The location of the TWRS-P Facility relative to the Hanford Site boundary is shown in Figure 1-4.

4.2.1.1 Process Building. The process building for the LAW-Only option contains processes for conditioning (i.e., pretreatment) and immobilizing the LAW feeds into glass. For the HLW/LAW option, the processes for conditioning and immobilizing HLW is also included. Additionally, for the LAW-only option, the process building includes an area for producing an intermediate waste form from the cesium separated from the LAW feeds. Figures 4-22 through 4-25 show the general arrangement of the process building for the HLW/LAW option.

The immobilized low-activity waste (ILAW) and the immobilized high-level waste (IHLW), and the cesium intermediate waste form are sealed in containers and placed in an interim storage area or process cells within the process building. Secondary waste streams (i.e., radioactive solid waste; nonradioactive, nondangerous liquid effluents; and radioactive, dangerous liquid effluents) are collected, sampled, analyzed, and returned to the DOE for treatment and disposal.

Gaseous effluents generated from processing the waste feeds are treated, sampled, analyzed, and discharged to the atmosphere through a stack whose top is 88 m (289 ft) abovegrade.

The overall dimensions of the HLW/LAW process building are approximately 249.8 m long by 96 m wide by 35.1 m abovegrade (819.6 ft long by 315 ft wide by 115 ft abovegrade). The overall dimensions of the LAW-only option process building are approximately 249.8 m long by 91 m wide by 35.1 m abovegrade (819.6 ft long by 299 ft wide by 115 ft abovegrade). The immobilization area extends belowgrade approximately 7 m (23 ft). The pretreatment area extends belowgrade approximately 14 m (46 ft).

The immobilization area includes remotely-operated vitrification systems contained in stainless-steel-lined concrete cells. The vitrification systems comprise feed makeup vessels, joule-heated melters, offgas treatment equipment, and waste-container handling, welding, and decontamination equipment. Glass-forming chemicals are stored in feedhoppers situated above the vitrification process cells, at 21 m (69 ft) abovegrade. The glass-forming chemicals are transferred through piping that penetrates the vitrification cells into the feed makeup vessels where they are blended with the waste stream. After vitrifying the waste, the waste containers are sealed, decontaminated, and transferred to an interim storage area within the process building.

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The waste container interim storage area is located adjacent to the immobilization area. Waste containers are transferred through one of two underground tunnels (7 m [23 ft] elevation) from the immobilization area into the interim storage area. Waste containers are stored in the interim storage area until the DOE accepts the immobilized waste. On acceptance of the waste, immobilized waste containers are transferred through an underground tunnel into the shipping container handling area using a shielded flask.

For the LAW-Only option, there is a cesium intermediate waste processing area that includes remotely operated equipment contained in stainless steel-lined concrete cells. The remotely operated equipment consists of vessels, ion-exchange columns, container welding, and decontamination equipment.

For both the LAW-Only and HLW/LAW option, the pretreatment area includes stainless steel-lined concrete cells that contain remotely operated equipment that performs the following operations:

1) Separates radionuclides from the LAW feed
2) Concentrates the separated radionuclides
3) Concentrates the pretreated LAW solution
4) Stages the pretreated LAW solutions for immobilization
5) Collects and monitors liquid effluents.

For the LAW-Only option, the area also includes provisions for the following:

1) Interim storage and transfer of the separated entrained solids, strontium, and transuranics (TRU) to the DOE via an underground pipeline

2) Interim storage of the technetium separated from the LAW feeds, with return to the DOE at the end of treatment services

3) Interim storage (as a solid) of the cesium separated from the LAW feeds.

For the HLW/LAW option, storage of separated solids and radionuclides is unnecessary because they are incorporated in the immobilized HLW product. Therefore, the HLW/LAW option also includes cells and equipment that:

1) Concentrate the HLW feed solution
2) Blend with the HLW feed, the radionuclides separated from the LAW feeds
3) Stage the blended HLW feeds for immobilization.

These pretreatment process cells begin at the -14 m (-46 ft) elevation and extend to 14 m (46 ft) abovegrade. Situated adjacent to the pretreatment process cells are bulges for accessing pumps and valves. The bulges are at the -7-m (-23-ft), 0-m (0-ft), and 7-m (23-ft) elevations.

A cooling water room that services the pretreatment area is situated at the 7-m (23-ft) elevation. In the cooling water room, the primary cooling water closed-loop system is monitored and cooled by the secondary cooling water loop.

An analytical laboratory is located on the west side of the pretreatment process cells. The laboratory is used to analyze samples of process solutions, products, and secondary waste. The analytical laboratory contains remotely operated cells and equipment for receipt and analysis of radioactive process and product samples. Additionally, fume hoods, gloveboxes, and analytical equipment are provided for handling and analysis of samples that exhibit low radiation levels.

A chemical reagents gallery is situated in the pretreatment area at the 14-m (46-ft) elevation. Tanks in the chemical reagents gallery receive chemical solutions from the wet chemical storage building and supply chemicals to vessels in the pretreatment process cells.

The process building contains various rooms for electrical distribution systems; backup battery power; heating, ventilating, and air-conditioning (HVAC) systems; instrumentation and controls; cooling water distribution; and miscellaneous workshops.

A shipping container area along with a drive-through loading bay is provided at the northeast corner of the process building adjacent to the area used for interim storage of the immobilized waste containers. Within this area, the shipping container provided by DOE is removed from the transport vehicle, the immobilized LAW or HLW/LAW container or cesium intermediate waste package is loaded into the shipping container, and the shipping container is placed onto the transport vehicle.

The area adjacent to the interim storage area is used for storage of immobilized waste containers. Sealed waste containers from the storage area are transferred into the shipping area using shielded flasks to reduce personnel radiation exposure.

4.2.1.2 Wet Chemical Store. The wet chemical store is located at grade on the southwest side of the process building. The exterior dimensions of the building are approximately 24 m wide by 36 m long by 9 m high (79 ft wide by 118 ft long by 30 ft high). A concrete loading pad is provided on the exterior west side of the building. Delivery trucks can park parallel or perpendicular to the building on a concrete loading pad.

The building is subdivided into an ion-exchange resin storage area and a bulk chemical reagents storage area. The ion-exchange resins storage area is enclosed by walls and a roof to prevent damage to these resin materials. Exterior access to the ion-exchange resins storage area is through a roll-up door located on the west side of the building. A stairway is provided for access to the building roof for service and maintenance of the air handling units.

Ion-exchange resins are brought into the process building from the wet chemical store through a double-door airlock on the east side of the resin storage area.

The bulk chemical reagents storage area does not have exterior building walls but is covered with a roof to protect the chemicals from the weather. The bulk chemicals are stored in tanks within spill-retention basins. Dry chemicals (e.g., ferric nitrate, strontium nitrate, and sodium nitrite) are stored separately in this area as well.
The chemical reagents stored in the bulk chemical reagents storage area are as follows:

1) 19 M sodium hydroxide solution
2) 1 M strontium nitrate solution

3) 5 M sodium hydroxide solution
4) 3.5 M ferric nitrate solution
5) 0.5 M sodium hydroxide solution
6) 0.5 M sodium nitrite solution
7) 12.2 M nitric acid solution
8) 5M nitric acid solution.

In addition, liquefied ammonia is stored on a pad outside the wet chemical store. The ammonia is used in the No_x destruction unit of the LAW melters off-gas treatment system.

Piping from the discharge pumps from the chemical storage tanks is routed through the exterior wall to the reagents gallery at the 14-m (46-ft) elevation within the process building.

4.2.1.3 Glass Formers Store. The glass formers store is used for receipt, storage, weighing, and blending of the bulk glass chemicals. The building is located at the east end of the process building and consists of a fabricated steel structure with insulated siding and roof. The building provides space for the chemical storage silos and seven blending vessels.

Trucks deliver the bulk material for glass-forming make up chemicals. On arrival and before the trucks unload, scales weigh the truck contents. A pneumatic vacuum system unloads the truck and charges a pneumatic transporter, which batch transfers the glass former ingredients to one of the bulk storage silos that provide a 14-day supply of the chemical. From the storage silos, the make up chemicals are weighed, blended, and transferred to the process building.

The glass formers store contains:

1) silica sand
2) zinc oxide
3) ferric oxide
4) zircon sand
5) lithium carbonate
6) boric acid
7) alumina
8) magnesium silicate
9) calcium silicate.

4.2.1.4 Tank 241-AP-106 Service Building. The tank 241-AP-106 service building supports new ventilation, instrumentation, electrical, and flushing equipment for tank 241-AP-106. The building is a preengineered rigid frame metal building with the finished floor level at grade level.

4.2.1.5 Central Pump Pit/Transfer Pump Pit Enclosure Building. The new pump pit enclosure provides both secondary confinement and weather protection to the mixer and transfer pump drive motors, the actuated transfer control valves and pit instrumentation. The building is a preengineered rigid frame metal building mounted on a concrete footing. The building is designed with removable roof sections to allow mixer and transfer pump replacement.

4.2.1.6 Transfer Pump Pit. A new cast-in-place or modular precast concrete transfer pump pit is installed above the tank 241-AP-106 risers 5 and 13 to provide location for two new transfer pumps and transfer control valves. The lower section of the pit is stainless steel-lined to provide adequate decontamination to meet requirements. Two existing tank ventilation ducts are presently routed directly below the proposed pit location. These ducts are encased in concrete in the area where they pass below the new pit.

4.2.1.7 Other buildings. The TWRS-P Facility includes the following additional buildings. These buildings were not included in the hazard evaluation as they do not contain significant quantities of hazardous materials. The building locations are shown in Figure 1-1.

Melter assembly building. This building is located at grade on the northwest side of the process building and adjacent to the empty canister store. The building is used for the storage and assembly of melters. The melter assembly building also serves as the main equipment access to the process building. An overhead crane is provided for assembly operations.

Empty canister store. This building is located at grade on the northwest side of the process building and adjacent to the melter assembly building. Empty waste canisters are unloaded, inspected, and stored in the building. Sufficient space is provided inside the building to store 120 empty LAW canisters or 20 empty HLW canisters. An overhead crane is provided to handle the canisters.

Services building. This building is located at grade on the west side of the process building. The building provides services to the process building. The building contains an electrical room, a clean maintenance shop, a clean electrical and instrument shop, water chillers, air receivers, after coolers, air compressors, and breathing air equipment.

Administration building. This building is located at grade on the northwest side of the process building. It contains change rooms, access control, the main control room, and offices and facilities for the operating staff.

4.2.2 Civil/Structural Design{tc \l3 "4.2.2 Civil/Structural Design}

This section addresses the civil and structural design of the TWRS-P Facility and the related codes and standards.

4.2.2.1 Soil Structure Interaction Analysis. The soil structure interaction is based on the finite-element method using substructuring technique and a two-and three-dimensional, linear finite element computer program. The program uses finite elements with complex moduli for modeling the structure and foundation properties and is based on the flexible volume method of substructuring and the frequency domain complex response method of analysis.

In performing the soil structure interaction analyses using the finite element method, the detailed structural models are coupled with the soil model. Structural responses in terms of accelerations, forces, and moments, are computed directly. Floor response spectra are obtained from the calculated response acceleration time histories. This effectively eliminates the need for a second-step structural response analysis in which the fixed-based structural model is subjected to the base motions resulting from the first-step soil structure interaction analysis. The direct solution also has an added advantage that the structural response to all components of base motion including rocking motion components for an embedded foundation is accounted for automatically in the solution.

The soil structure interaction analyses for the three-directional earthquake components are performed separately. The maximum co-directional responses to each of the three earthquake components are combined using the square-root-sum-of-the-squares method to obtain the combined maximum structural responses in each selected degree of freedom of interest.

4.2.2.2 Seismic Analysis of the Process Building. Seismic analysis of the process building is accomplished using the response spectrum or time-history approach. The time-history approach is made either in the time domain or in the frequency domain. Either approach uses the natural period, mode shapes, and appropriate damping factors of the particular system toward the solution of the equations of dynamic equilibrium. The time-history approach may alternatively use the direct integration method of solution. When the structural response is computed directly from the coupled structure-soil system, the time-history approach solved in the frequency domain is used.

A lumped-mass stick model of the building is used for seismic analysis. The mathematical model reflects the stiffness, mass, and damping characteristics of the structural systems. Enough points on the structure are used for evaluation of maximum relative displacements. Locations of Design Class I and II equipment are taken into consideration in the analysis.

Coupling between the two horizontal motions occurs when the center of mass, the centroid, and the center of rigidity do not coincide. The degree of coupling depends on the amount of eccentricity and the ratio of the uncoupled torsional frequency to the uncoupled lateral frequency. Because lateral/torsional coupling and torsional response can significantly influence floor accelerations, structures are in general designed to keep eccentricities at a minimum. Table 4-15 provides quantitative seismic design criteria to be applied.

4.2.2.3 Design for Natural Phenomena Hazards. SSCs designated as Design Class I and II are designed to withstand the effects of natural phenomena such as earthquakes, high wind, and floods without loss of capability to perform their safety functions required as a result of the NPH. SSCs required to perform a safety function as a result to a NPH are designed to withstand the NPH loadings of that NPH provided in Table 4-13. Otherwise the loadings in Table 4-14 are used. The design basis for Design Class I and II SSCs reflect the following:

Table 4-15. TWRS-P Facility Seismic Design Criteria for Dynamic Analysis

Item	TWRS-P Facility Design Basis Earthquake
Scale factor, SF	1.0
Inelastic energy absorption factor, FF	1.0
Maximum material damping value for soil (percent of critical):	15
Damping values for structures (percent of critical): 1) Reinforced concrete structures	 7

Table 4-15. TWRS-P Facility Seismic Design Criteria for Dynamic Analysis

Item	TWRS-P Facility Design Basis Earthquake
2) Bearing bolted steel structures	7
3) Friction bolted steel structures	4
4) Welded steel structures	4
Damping values for systems and components (percent of critical):	
1) Reinforced concrete structures	4
2) Bearing bolted steel structures	4
3) Friction bolted steel structures	2
4) Welded steel structures	2
5) Large-diameter piping (diameter > 12 in.)	3
6) Small-diameter piping (diameter # 12 in.)	2
7) Pumps, motors, and instrument racks	2
8) Electrical cabinets and other equipment	3
9) Liquid containing metal tanks - Impulsive mode	2
10) Liquid containing metal tanks - Sloshing mode	0.5

1) Appropriate plausible combinations of the effects of normal and accident conditions with the effects of the natural phenomena

2) The importance of the safety function to be performed during and after the event.

Those portions of SSCs whose continual safety function is not required but whose failure as a result of an NPH event could reduce the functioning of the Design Class I SSCs, such that the public exposure standards of Section 4.6.4.1, AProtection of Public Safety@ are exceeded are designed to withstand the NPH loading in Table 4-13.

Those portions of SSCs whose continual safety function is not required but whose failure as a result of an NPH event could reduce the functioning of the Design Class II SSCs, such that the worker exposure standards of Section 4.6.4.2, AProtection of Worker Safety@ are exceeded are also designed to withstand the NPH loading in Table 4-13.

For most cases, a static analysis is applied to these SSCs that could fail Design Class I and I SSCs. In addition, piping is designed to meet faulted conditions, ductwork is not allowed to collapse, and structures are designed and analyzed to demonstrate the NPH will not cause failure of the protected Design Class I or Design Class II SSC to perform its specified safety function.

4.2.2.4 Piping and Pipe Support Codes. The design of Design Class I and II piping and pipe supports are performed in accordance with the UBC (ICBO 1994), ASME B31.3, *Process Piping*, and the American Institute of Steel Construction, *AISC Manual of Steel Construction - Allowable Stress Design.*

Uniform Building Code. The UBC provides design methods to compute earthquake loading to design piping and pipe supports. The design coefficients are governed by factors such as the type of facility (chemical handling or power generation), its location (earthquake zones), and its occupancy rate.

ASME B31.3, *Process Piping*. The code provides equations to compute the piping stress levels under various loading conditions, such a deadweight, earthquake, wind (dynamic), and thermal expansion. It also provides the allowable stress levels for each load condition and for the combination of the loading conditions.

AISC *Manual for Steel Construction - Allowable Stress Design*. This standard provides the allowable stress levels for structural steel for the pipe support design.

4.2.2.5 Piping and Pipe Support Design. The piping design for the TWRS-P Facility is based on the facility design specification. This specification indicates which of the codes and standards listed in Section 4.2.2.4, "Piping and Pipe Support Codes" are to be applied. For earthquake load design of the piping, the specification may indicate application of the UBC or more stringent requirements to provide added safety. In all cases, the UBC is the minimum requirement. The specification may indicate compliance with ASME B31.3, *Process Piping*.

The design of piping consists of assuring that the piping develops acceptable stress levels when subjected to deadweight, earthquake loading, and thermal expansion loading. This is achieved by placing pipe supports and restraints at strategic locations and in appropriate directions on the piping and providing pipe routing with sufficient flexibility. Piping is designed using one of the two methods described below.

Span Approach. Using the requirements of the facility design specification, piping spans are developed for various pipe sizes in such a way that pipe supports placed at these spans result in acceptable stress levels in the piping. The span developed is the maximum distance along the pipe between two supports in the horizontal and vertical directions.

Computer Analysis Approach. For this approach, the piping is represented in a mathematical model using a standard computer program for piping analysis. The appropriate loading is applied and the results of the analysis are examined for piping stress levels. When the stress levels do not comply with the allowable stress limits according to ASME B31.3, *Process Piping*, supports or restraints are added. This process is repeated until the piping stress levels are within code specified stress limits.

This piping design process. By either the span or computer analysis approach, the types of supports (e.g., horizontal, vertical, rigid or spring), their location on the piping, and the piping loads imposed on the supports are provided. Pipe support design consists of selecting appropriate pipe support hardware from supplier's catalog or designing structural framing to resist the imposed loads. For the standard pipe support hardware, the supplier provides the support load capacity. Therefore, design of a support requires the selection of a component with a load capacity greater than the imposed load. No additional analysis is required. When a structural frame is designed to support piping, it requires analysis to verify that the stress induced by the imposed loads is within the allowable stress limits according to *AISC Manual of Steel Construction - Allowable Stress Design*. This analysis may be a hand calculation or a computer analysis in which the mathematical model of the structural frame is analyzed while it is being subjected to imposed loads. A standardized approach often is used for the frame design. Several common frame configurations are prequalified, with computer analysis if required, for a range of loads.

4.2.3 Constructability, Operability, Reliability, Availability, Maintainability and Inspectibility (CORAMAI){tc \l3 "**4.2.3 Constructability, Operability, Reliability, Availability, Maintainability and Inspectibility (CORAMAI)}**

4.2.3.1 Constructability. The Construction Industry Institute (CII) defines constructability as:

> AThe optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives.@

The CII has conducted extensive research in the field of constructability. Early research by a CII constructability task force identified the following general characteristics of projects that emphasize constructability.

1) Owner and contractor managers, including engineering, procurement and construction, are committed to the cost effectiveness of the whole project. They recognize the high cost influence of early project decisions and use constructability as a major tool in meeting project objectives.

2) These managers bring construction personnel aboard early, who are experienced and have a full understanding of how a project is planned and built.

3) Designers and engineers are receptive to constructability. They think constructability, request construction input freely, and evaluate that input objectively.

The CII also developed a list characteristics of the constructability process. The concepts are paraphrased as follows and are organized into two groups by project phase: early project planning and project execution.

1) Constructability Concepts During Early Project Planning

    a) Make constructability an integral part of project execution plans.

    b) Actively include construction knowledge and experience in project planning.

    c) Construction involvement is essential when developing contracting strategies.

    d) Recognize that construction often drives the overall project schedule.
    e) Consider previously proven construction methods in basic design approaches.

    f) Promote efficient construction operation and maintenance through effective site layouts.

2) Constructability Concepts During Project Execution

a) Configure designs to enable efficient construction.

b) Standardize design elements to enhance constructability.

c) Create design and procurement schedules that support construction.

d) During design, plan for and provide construction accessibility for personnel, material, and equipment.

e) Consider construction efficiency when developing specifications.

f) Develop module and preassembly designs that facilitate fabrication, transport, and installation.

g) Create designs that facilitate construction under adverse weather conditions.

h) Explore innovative construction methods to enhance constructability.

The TWRS-P Project constructability program includes the characteristics identified by the CII as elements of a constructability program plus the following concepts of the existing Bechtel National, Inc. (BNI) constructability program.

1) Constructability is a process.

   Constructability is not a Aone-shot@ effort. Integrating the efforts of different groups, including owners, engineers, and constructors, is an ongoing process of learning and improvement. It is an ongoing process where lessons are learned from previous projects to develop a comprehensive lessons learned database. It is also an ongoing process on each project, as the project progresses and passes through distinctive phases. Because constructability is a process, it is closely linked to the BNFL team=s philosophy.

2) Constructability is Appropriate for Every Project.

   Constructability is a fundamental approach to project development and execution. It is applicable to all projects, large or small, complex or simple, and of any duration. It is not restricted to large projects, nor is it appropriate only on complex projects or projects with a specific scope.

3) Constructability requires focus and organization.

   Constructability does not Ajust happen.@ While each project will differ in the degree of formalization of a program, each project will require constructability leadership and organization. Leadership means having project management committed to constructability concepts and designating a construction representative as a focal point for constructability. Organization means building a project-specific constructability plan to support project objectives.

4) Constructability is everyone=s responsibility.

> The concept of a construction representative as a coordinator does not mean it is only one person's responsibility for practicing constructability. Every member of the project team has the opportunity and responsibility to contribute to the constructability with new ideas and past experiences.

Relative to the aspects of a constructability program concerning the development of a design that promotes efficient construction, no Design Class I or II features of the TWRS-P Facility have been identified that would impede the efficient construction of the facility.

4.2.3.2. Operability, Reliability, Availability, Maintainability and Inspectability. For SSCs required to perform a safety function, the facility design ensures reliability commensurate to the importance of that function, the ability to carry out required maintenance activities and that the most appropriate inspection regime is adopted.

SSCs identified as performing safety functions, i.e. Design Class I or II, have a regular inspection, testing and maintenance regime to ensure that the specified function is being carried out. All SSCs performing a safety function are performance tested with a frequency commensurate with specific reliability requirements. These requirements are different for each SSC, dependent on the importance of the safety function. A testing frequency is specified in the TSRs or the LCRs and incorporated into the maintenance schedule. The ability to inspect out-cell SSCs is factored into their design, however additional considerations are applied to in-cell equipment required to perform a safety function.

In-cell equipment is designed either to perform for the specified operating life of the facility, or to be replaceable. For in-cell equipment required to perform a safety function and designed to last the life of the facility, the design will demonstrate that it will perform for that time. The testing and inspection requirements developed to demonstrate the reliability and operability of such equipment are specified in the TSRs or the LCRs. Inspection to demonstrate continuing performance is either direct (e.g., vessel or component inspection via regular camera inspections using remote handling) or indirect (e.g. using coupons sited within a cooling water circuit serving the active process to determine the corrosion rate of the in-cell pipework.). Equipment is designed such that its continuing operability can be monitored by facility staff during testing. If the inspection or testing of in-cell equipment requires that it be taken out of service, substitution arrangements are designed to ensure that specified safety functions are not interrupted. If substitution arrangements are not provided for equipment, the facility is placed in a condition in which its specific safety function is not needed or the time allowed for the test or inspection is limited to the time during which the SSC is not required to perform. To support these restrictions, SSCs with surveillance requirements that are required to be demonstrated during a facility shutdown are designed with a reliability and projected availability commensurate with the operating cycle between planned facility shutdown maintenance periods.

SSCs that are not designed with a lifetime commensurate with the life of the facility are designed with features to facilitate their replacement. In such cases the design provides appropriate means to carry out the replacement (e.g. remote handling and decontamination facilities). During the planned replacement activities, adequate redundancy or defense in depth is available to ensure specified safety functions are maintained.

In summary, the specifications for Design Class I and II SSCs are developed so that the SSC is available and operable during the required time frame. SSCs are designed and installed so that the operability can be demonstrated by tests and inspections during which the required safety function is maintained. To achieve this, SSCs are provided with adequate redundancy, defense in depth and accessibility which are commensurate with the required safety function. The TWRS-P facility design does not add any challenges to inspectability, maintainability, operability and testability that have not already been dealt with at similar BNFL facilities.

4.2.4 Safety Criteria, Codes, and Standards{tc \l3 "4.2.4 Safety Criteria, Codes, and Standards}

The TWRS-P Facility design and construction is in accordance with the Safety Requirements Document (SRD) (BNFL 1997g) Safety Criteria identified in Table 4-16.

The following codes and standards are applied to the Design Class I and II civil and structural features of the TWRS-P Facility.

1) ACI 318-95, *Building Code Requirements for Structural Concrete*

2) ACI 349-90, *Code Requirements for Nuclear Safety-Related Concrete Structures*,

3) AISC-MO16-89, *Manual for Steel Construction - Allowable Stress Design, Ninth Edition*

4) AISC N690-95, *Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*

5) ASCE 4-86A, *Seismic Analysis of Safety-Related Nuclear Structures and Commentary*

6) ASCE 7-95A, *Minimum Design Loads for Buildings and Other Structures*,

7) ASME B31.3-96, *Process Piping*

8) DOE-STD-1020-94 (Change 1, 1996), *Natural Hazards Design and Evaluation Criteria for Department of Energy Facilities*

Table 4-16. SRD Safety Criteria Specific to Civil/Structural Design and Construction

SRD Safety Criteria	Subject[1]
4.1-2	Design, fabrication, erection, construction, testing, and inspection of the facility commensurate with the importance of the safety function to be performed
4.1-3 and -4	Natural phenomena hazards
4.1-5	Protection against the dynamic effects of failure of moderate and high energy systems
4.5-2	Buildings containing a significant quantity of radioactive or hazardous material shall be constructed of noncombustible or fire-resistant material, where appropriate
4.5-6	The design shall incorporate life safety features including a means to evacuate building occupants in the event of a fire.
4.5-8	The facility shall include physical access to facilitate effective intervention by the Hanford Site Fire Department.
4.5-9	The facility shall provide for the prevention of accidental release of significant quantities of contaminated products of combustion and fire water. This can be provide by such features as curbs, dikes, and holding ponds.
4.5-10	Fire and related hazards that are unique to the facility and are not addressed by industry codes and standards shall be protected by isolation, segregation, or use of special fire control features such as inert gas or explosion suppression, as determined by the fire hazards analysis.

Note: [1] Refer to the *Safety Requirements Document* (BNFL 1997g) for the complete wording of the listed Safety Criteria.

9) DOE-STD-1021-93 (Change 1, 1996), *Natural Phenomena Hazards Performance Categories Guidelines for Structures, Systems, and Components*

10) NFPA 801-95, *Standard for Facilities Handling Radioactive Materials*

11) DOE G-440.1A, *Implementation Guide for Use with DOE Orders 420.1 and 440.1*

12) DOE-STD-1066-97, *Fire Protection Design Criteria*

13) UBC 1994A, *Uniform Building Code*.

In addition the TWRS-P Facility construction activities are incompliance with 29 CFR 1926, ASafety and Health Regulations for Construction.@

4.3 PROCESS DESCRIPTION{tc \l2 "4.3 PROCESS DESCRIPTION}

This section provides descriptions of the chemical processing systems and the electrical and mechanical support systems. This section also addresses the potential need for Design Class I and II systems and components based on the conceptual design of the facility. Additional or different features may be identified during Part B.

For the LAW-Only option, the waste feeds to the facility consist of liquid feeds with low solids content. Specification 7 of the contract (DOE-RL 1996d) states that the insoluble solids fraction of the LAW will not exceed 5 vol % of the waste transferred. The ILAW has radionuclide concentrations less than Class C limits, as this limit is defined in 10 CFR 61.55. The average concentrations of cesium-137, strontium-90, and technetium-99 in the ILAW are further limited by Specification 2 of the contract (DOE-RL 1996d) as follows: cesium-137 <3 Ci/m^3, strontium-90 <20 Ci/m^3, and technetium-99 <0.3 Ci/m^3.

Concentrations of these radionuclides in the LAW waste envelopes are too high to meet these limits. Therefore, the pretreatment of the LAW includes process steps for removing these three radionuclides, as well as entrained solids, from the feed before vitrification and incorporating them into waste forms for storage and eventual return to DOE as described in Specifications 3, 4, 5, and 6 of the contract (DOE-RL 1996d). In addition to specific limits for radionuclides, the surface dose rate of the ILAW can not exceed 1,000 mrem/h, which places additional requirements on package shielding.

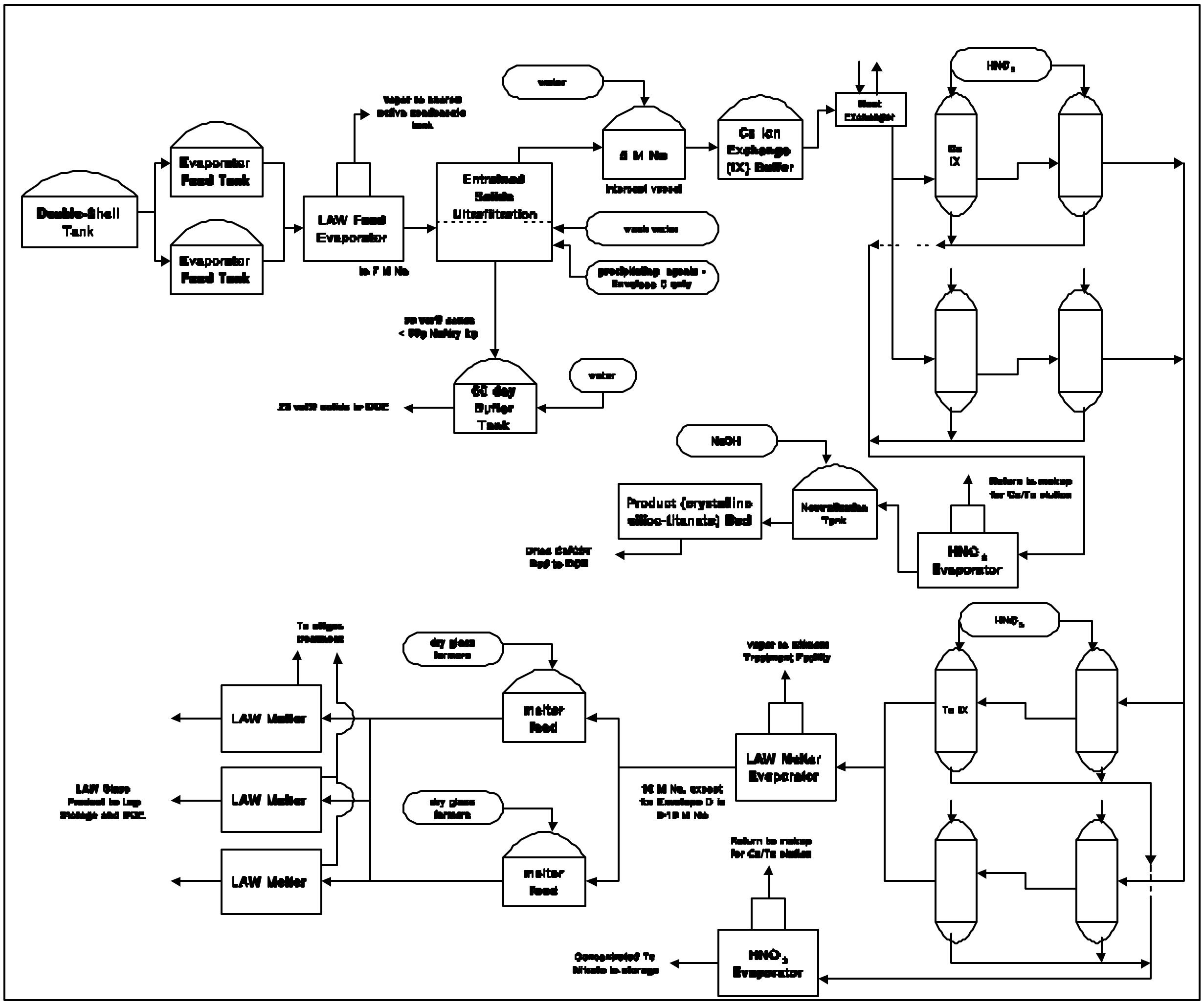
For the HLW/LAW option, two processes proceed in parallel. One process treats the same LAW streams as the LAW-only option, yielding the same ILAW product. The other process is designed to receive and treat HLW sludges (e.g., aging waste from the Hanford DST and the sludge retrieved by sluicing from single-shell tank [SST] 241-C-106). The expected composition of the HLW feed (Envelope D waste) is given in Specification 8 of the contract (DOE-RL 1996d). The bulk of the HLW feed components is in the form of insoluble suspended solids in an aqueous slurry. The immobilized high-level waste (IHLW) product has significantly higher activity than the product from the LAW. The IHLW product container dose rate is IE5 rad/hr vs. rem/hr for the LAW product container.

The major difference between the two options is that an HLW melter receives solids-bearing waste, while an LAW melter receives only liquids. In the combined HLW/LAW option, the radionuclides recovered during pretreatment of the LAW feeds are (e.g., Cs, Tc, Sr, and TRU) routed for mixing with the Envelope D waste for processing by the HLW melter. The filtrate streams generated by ultrafiltration of the HLW are routed to the LAW pretreatment process.

Figures 4-28 and 4-29 provide simple flow diagrams for the LAW-Only and the HLW/LAW options, respectively.

4.3.1 Waste Receipt, Pretreatment, and Vitrification{tc \l3 "4.3.1 Waste Receipt, Pretreatment, and Vitrification}

This section discusses the details of waste receipt, pretreatment, and vitrification.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Evaporator Feed Tank
Evaporator Feed Tank
LAW Feed Evaporator
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Cs Ion Exchange (IX) Buffer
Heat Exchanger
HNO3
Cs IX
wash water
water
60 day Buffer Tank
NaOH
Neutralization Tank
Product (crystalline silico-titanate) Bed
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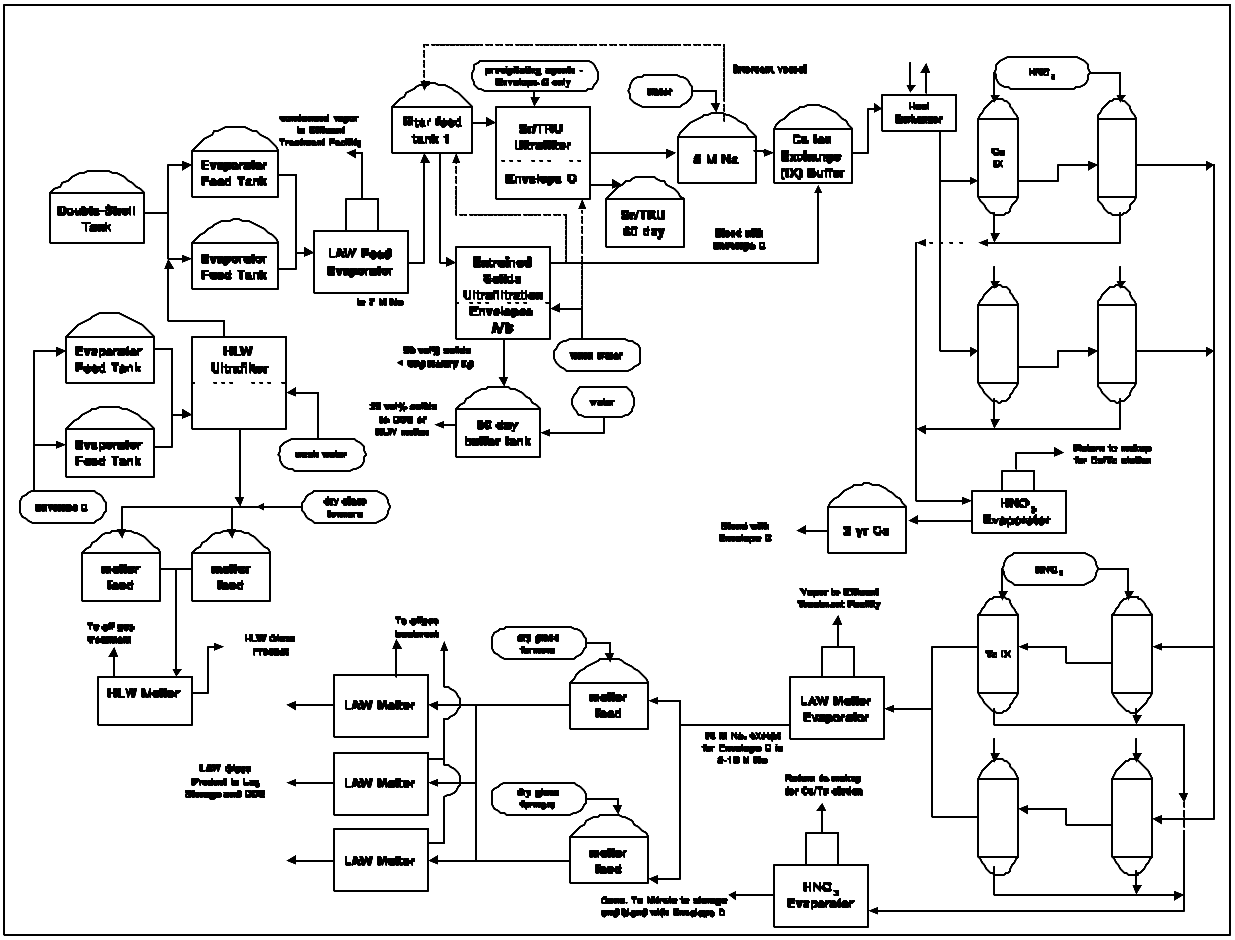
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Evaporator Feed Tank
Evaporator Feed Tank
LAW Feed Evaporator
filter feed tank 1
Sr/TRU Ultrafilter
Envelope D
Sr/TRU 60 day
5 M Na
Cs Ion Exchange (IX) Buffer
Heat Exchanger
Entrained Solids Ultrafiltration Envelopes A/B
wash water
water
50 day settler tank
Evaporator Feed Tank
Evaporator Feed Tank
HLW Ultrafilter
wash water
dry glass formers
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4.3.1.1 Waste Receipt. The processing of the LAW for both options starts with waste sent from DOE into the existing tank 241-AP-106. Four new double-contained transfer pipes are to be used to transfer waste between the AP farm and the TWRS-P Facility. Two pipes connecting tank 241-AP-106 to the TWRS-P Facility are used to transfer LAW Envelopes A, B, and C, and return solids. The pipes are configured to support waste feeds to the TWRS-P Facility through one line and return solids to DOE through the other. A cross connection is provided between the pipes in the transfer pit as a backup in the event of a line failure. The remaining two pipes connect to a new caisson provided by DOE to transfer HLW feed (Envelope D) to the facility. The inner pipes are stainless-steel and the outer pipes are carbon steel. The pipes are sloped to the TWRS-P Facility. A leak detection system is provided for all four pipes.

LAW Envelope A, B, or C feeds are transferred, in approximately 200-m^3 (52,800-gal) batches, from the DST to one of the two LAW Evaporator Feed Vessels. Envelope D feeds are received into the three Envelope D receipt vessels, each with a capacity of approximately 225 m^3 (59,400 gal) in batches containing at least 5 Mt of equivalent waste oxide (excluding sodium and silicon). Each batch transfer of HLW and LAW is followed by a water flush of the affected components.

4.3.1.2 LAW Feed Evaporator. The LAW feed stream is evaporated to provide a consistent feed concentration and minimize the volume throughput of the pretreatment process. The LAW feed evaporator is a continuous, submerged-tube, forced-circulation evaporator. The evaporator concentrates the feed to approximately 7 M sodium to provide a consistent feed for the cesium ion-exchange process. The LAW feed is recirculated at a high flow rate through the evaporator reboiler until the sodium content of the stream reaches the desired concentration. The concentrated LAW product stream is then pumped to a buffer vessel before entrained solids removal. The vapor stream is condensed and the condensate routed to the shared active condensate tanks, which receive condensate from several evaporators in the LAW pretreatment process. The condensate is sampled, analyzed, and discharged to the DOE Effluent Treatment Facility (ETF).

4.3.1.3 Entrained Solids Removal by Ultrafiltration. For both options, the concentrated LAW product is sent to the ultrafiltration loop to separate entrained solids. Envelope C waste, strontium, and TRU elements require removal to meet the product specifications for the ILAW glass product. To accomplish this, reagents are added to precipitate strontium and TRU elements before sending the waste through the ultrafiltration loop. For the HLW/LAW option, the entrained solids are first separated, then the Sr/TRU precipitation process is conducted. Continuous circulation through a crossflow filter removes the entrained solids and precipitate. For the LAW-Only option, the precipitated solids, (strontium and a ferric floc containing the TRU elements) are returned to the DOE. For the HLW/LAW option, the precipitates are sent directly to be mixed with Envelope D feed for processing by the HLW Melter.

4.3.1.4 Cesium and Technetium Removal Using Ion Exchange. To meet ILAW product specifications, the radioactive cesium and technetium content of the LAW feed must be reduced. This reduction is accomplished by passing the feed through successive ion-exchange systems for cesium and technetium removal. The cesium is removed first. The cesium ion-exchange medium is a SuperLigand- SL644 **J** [(1)]. The technetium removal system uses Reillex -HPQ **J** [(1)] or SuperLigand- SL639 **J** [(1)] resin.

[(1)] SuperLigand-SL644 is a registered trademark of IBC Advanced Technologies, Inc., American

Both systems have two sets of columns in parallel. Each set has two columns in series. One set is collecting while elution and regeneration are occurring on the other set. When cesium or technetium can be detected in the effluent from its respective columns, the flow to that set of columns is suspended, and the LAW is diverted to the other set of columns.

The cesium and technetium subsequently are removed from the loaded columns, and the resin regenerated for reuse. The cesium resin has an anticipated useful life of at least 10 cycles, after which the spent resins are removed from the columns and replaced with fresh resin. The spent resins are processed in the LAW melter.

4.3.1.5 Cesium/Technetium Nitric Acid Recovery. The eluate from both the cesium and technetium ion exchange are put through separate evaporative processes to recover some of the nitric acid and to concentrate the solutions. The recovered nitric acid is reused in the process. For the LAW-only option, the cesium concentrate goes to a neutralization tank to be prepared for recovery onto a solid substrate. It is then packaged and returned to the DOE for storage.

For the LAW-Only option, the concentrated technetium solution is returned to the DOE at the end of Phase I. For the HLW/LAW option, the cesium concentrate is stored with the technetium and both are mixed with Envelope D waste for processing by the HLW melter.

4.3.1.6 Cesium Recovery as a Solid. The storage of cesium as a dry powder is a requirement of the contract Specification 4.2.2 for the LAW-only option (DOE-RL 1996d). To meet this requirement, the cesium in the concentrate from the evaporator is adsorbed onto another ion-exchange material, crystalline silico-titanate (CST). The acid concentrate is first neutralized with sodium hydroxide, then passed through the bed of CST. The cesium-loaded bed is subsequently dried by a combination of its own heat generation and a slow passage of air. Once the air feed through the bed reaches its low moisture content limit, the bed is packaged in outer containers. The cesium product canisters are sealed, decontaminated, tested, and stored in racks waiting transfer to DOE for storage.

4.3.1.7 LAW Melter Evaporator. After the LAW stream has passed through the cesium and technetium ion-exchange system, it is sent to the LAW melter evaporator for concentration to approximately 8 M to 10 M sodium. This further concentration reduces the electrical power

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Fork, Utah.

(1) Reillex-HPQ is a registered trademark of Reilley Industries.

(2) SuperLigand-SL639 is a registered trademark of IBC Advanced Technologies, Inc., American Fork, Utah.

requirements of the LAW melters by minimizing the quantity of water that is evaporated within the melters. The process condensate stream is routed to the shared active condensate tanks. If laboratory analysis shows that the shared active condensate is within discharge limits for radionuclide concentration, it is discharged from the building to the DOE ETF located outside the TWRS-P Facility.

4.3.1.8 LAW Glass Melter. The nominal design capacity of each LAW melter is 10 Mt of glass per day. However, up to three LAW glass melters operate in parallel to achieve the production goal of about 18 Mt of glass per day. The feed to the melters is a slurry of the concentrated LAW from the evaporator and a blended mixture of dry glass-forming chemicals. The glass-forming chemicals are delivered to the Hanford Site in bulk by truck and stored in silos located near the process building.

Nine glass-forming chemicals are expected to be needed to produce the required LAW glass recipe for feed Envelopes A, B, and C. These are silica, alumina, boric acid, calcium silicate (wollastonite), ferric oxide, lithium carbonate, magnesium silicate (olivine), zircons and zinc oxide. From the storage silos, the dry chemicals are weighed and transferred into pneumatic blending silos. The blending silos use compressed air to blend a 24-hr batch of dry chemicals for each LAW melter. Two blending silos are provided for each melter. One silo is blending while the other is sampled and analyzed to confirm that the blend is within specification. After blending, the glass formers are transferred to a feed hopper within the main facility until required for use. There is a glass-former feed hopper for each melter sized for 8 hrs capacity.

The LAW melter feed consists of the LAW concentrate from the LAW evaporator blended with the glass-forming chemicals from the feed hopper. A batch of sampled LAW concentrate is transferred into the LAW melter feed preparation vessel. Dry chemicals from the storage hopper are metered into the vessel. The thoroughly mixed feed slurry then is transferred into the LAW melter feed vessel. The melter feed vessel is fitted with six fluidic pumps, which deliver the slurry to six feed nozzles on the melter.

The LAW glass melters are electrically-heated (joule-heated) ceramic melters designed to incorporate the metal oxides in the feed slurry into glass while the liquid water is vaporized. The operating temperature of the melter is approximately 1150EC (2100EF). Unreacted feed components form a cold cap on the surface of the molten glass. This cold cap helps to minimize the loss of volatile components from the molten glass pool to the off-gas system. The external surfaces of the melter are cooled by an integral cooling water jacket to reduce heat losses to the cell and prevent molten glass migration through and corrosion of the refractory package. Air bubblers agitate the glass pool to improve the rate of heat transfer to the cold cap and enhance the rate of incorporation of the feed into the molten glass.

Each melter has two discharge chambers. Each chamber has two container-filling ports. The redundant ports are installed to minimize down time. Vacuum or air lift risers raise the glass pool above the level of the discharge weir. The glass then flows, by gravity, through one of the discharge chambers and filling ports into the stainless steel ILAW container.

4.3.1.9 HLW Glass Melter. For the HLW/LAW option, in addition to the LAW glass melters, there is another melter system to process HLW. The facility design will allow installation of two HLW melters. The feed to a HLW melter is concentrated Envelope D sludge and other HLW feeds from pretreatment including strontium/TRU precipitate, cesium ion-exchange eluate, and technetium ion-exchange eluate. The design throughput of the HLW melter is 1.5 Mt of glass per day.

The LAW glass former storage also supplies the HLW melter. However, to accommodate variations in the composition of Envelope D feed, a different glass formulation is required. At this time, five chemical additives are identified for the HLW glass recipe including, silica, boric acid, calcium silicate (wollastonite), ferric oxide, and lithium carbonate.

Weighing and blending of the dry chemicals and mixing with the HLW feed is essentially the same as for the LAW melters. The blended melter feed is sampled and tested for acceptable composition and then transferred to the HLW melter feed vessel. Fluidic pumps transfer the feed through feed nozzles into the melter.

The HLW melters are also electric-heated (joule-heated), slurry feed melter, with an integral cooling water jacket. The operating temperature of the melter is approximately 1150EC (2100EF). In the melter, the feed flows across the molten glass surface and forms a cold-cap on the surface of the melt.

Glass is discharged from the HLW melter via one of two redundant discharge chambers. As described for the LAW melter, a lift system removes the glass from the melter for subsequent discharge to IHLW canisters.

4.3.1.10 Container Sealing and Decontamination. The vitrified product containers for both the LAW and the HLW are constructed from stainless-steel. After charging with vitrified waste, the containers are allowed to cool, and a stainless steel lid is welded on. The LAW containers are rectangular in shape with the approximate external dimensions of 1.8 m by 1.2 m by 1.2 m (6 ft by 4 ft by 4 ft). The HLW containers are cylindrical canisters about 3 m (10 ft) long with a diameter of 0.61 m (24 in.). The facility design is also capable of handling HLW canisters that are 4.5 m (15 ft) long.

Contamination of the outer container walls could occur during filling. Activity on the outside of the container is removed before the containers are handled for storage. After it is sealed, the product container is moved to a decontamination booth in a decontamination cell, where surface contamination is removed using ultra-high-pressure water. The washings are collected in the base tray of the decontamination booth and drained to a dedicated catch vessel. Glass particles are collected and dispositioned as either radioactive solid waste or non routine high level solid waste. The water in the catch vessel is periodically discharged to a dedicated ETF facility discharge vessel. The decontaminated container is transferred to the adjacent control cell for monitoring and eventually transferred to the vitrified product storage area.

4.3.1.11 Waste Receipt, Pretreatment, and Vitrification Interfaces and Design Criteria. The waste receipt, pretreatment, and vitrification operations interface with the following systems:

1) Integrated control system - provides process control and monitoring

2) Chilled water system - provides cooling for pretreatment columns, heat exchangers, vessels, and the external jackets of the melters

3) Process air system - provides air for pneumatic conveying and blending, filter blowdown, aeration jets, air purge seals, feed and feed transfer pumps, melter bubblers, melter air lift, and melter film coolers

4) Instrument air system - provides air for the melter level sensors

5) High-pressure steam system - provides steam to ejectors

6) Low-pressure steam system - provides steam to LAW feed evaporator reboiler, cesium and technetium nitric acid recovery evaporators, melter feed evaporator reboiler, concentrate collection tanks

7) Demineralizer water system - provides water for process chemical makeup, throughout the waste treatment process.

8) Electrical system - provides power for conveyers, agitators, pump, and valve motors, damper control, melter electrodes, and the melter startup lid, and discharge heaters.

The HLW receipt tanks (HLW/LAW option) are designated as Design Class I. The LAW receipt tanks (both options), the technetium/cesium product storage tank (HLW/LAW option), the cesium product canister storage racks (LAW-Only option) (See Section 4.3.1.6, ACesium Recovery as a Solid@), and the nitric acid and ammonia storage tanks are designated as Design Class II. In addition, these tanks and the cesium canister storage racks are designed for the DBE loadings of SRD Safety Criterion 4.1-3.

The above-listed Design Class I and II tanks are designed, constructed, and operated in accordance with the SRD safety criteria identified in Table 4-17. In addition, the tanks are designed to the following implementing codes and standards:

1) ASME B31.3, *Process Piping*
2) ASME Section VIII, *Boiler and Pressure Vessel Codes*
3) API 620, *Vessels* (for <15 psig)
4) API 650, *Atmospheric Vessels*.

Table 4-17. SRD Safety Criteria Applicable to Design Class I and II Tanks

SRD Safety Criterion	Subject[1]
	SSCs shall be designed to withstand the effects of natural phenomena without loss

Table 4-17. SRD Safety Criteria Applicable to Design Class I and II Tanks

SRD Safety Criterion	Subject[1]
4.1-4	of safety function.
4.4-3	Design Class II systems and components shall be designed and constructed to permit testing, inspection, and maintenance throughout their operating life to verify continued acceptability for service with an adequate safety margin.
4.4-6	The design shall ensure operability under normal and accident conditions. The design shall permit appropriated periodic inspection and pressure and functional testing to address: 1) The structural and leaktight integrity of its components 2) The operability and the performance of active components of the system such as fans, filters, dampers, pumps, and valves 3) System operability as a whole.
4.2-1	The facility shall be designed to retain the radioactive material through a conservatively designed confinement system for normal operations, anticipated operational occurrences, and accident conditions. The confinement system shall protect the worker and public from undue risk of releases such that the radiological and chemical exposures standards of SRD Safety Criteria 2.0-1 or 2.0-2 are not exceeded.
4.2-2	Design Class II liquid and gaseous systems and components shall be designed to retain their hazardous inventory such that the radiological and chemical exposures standards of SRD Safety Criteria 2.0-1 or 2.0-2 are not exceeded.
4.2-3	Codes and standards for vessels and piping should be supplemented by additional measures (such as erosion, corrosion programs) to mitigate conditions that could result in exceedance of the radiological and chemical exposures standards of SRD Safety Criteria 2.0-1 and 2.0-2.
4.2-4	Design Class II liquid and gaseous storage systems shall have continuous monitoring to detect the loss or degradation of their safe storage function.

Note: [1] Refer to the *Safety Requirements Document* (BNFL 1997g) for the complete wording of the listed Safety Criteria.

The Design Class II cesium canister storage racks are designed to the following implementing codes and standards:

1) AISC, *Manual of Steel Construction - Allowable Stress Design*,

2) AISC N690, *Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*.

This is the LAW transfer line for both LAW and HLW/LAW options. What is Design Class for HLW transfer line? The tank 241-AP-106 transfer lin is designated as Design Class II. Other components related to waste receipt, pretreatment, and vitrification are designated as Design Class III. However, for defense in depth, the technetium concentrated storage tank (LAW-Only option), the cesium product storage tank (HLW/LAW option), and the HLW receipt tank (HLW/LAW option), and the HLW receipt tank (HLW/LAW option), are designed to withstand the DBE of SRD Safety Criterion 4.1-3.

The design, construction, and operations of the Design Class II tank 241-AP-106 transfer line are in accordance with the SRD Safety Criteria (BNFL 1997g) identified in Table 4-17.

The tank 241-AP-106 transfer line is designed to following implementing codes and standards:

1) ASME B31.3, *Process Piping*
2) ASME Section VIII, *Boiler and Pressure Vessel Codes*

4.3.2 Melter Offgas Treatment Systems{tc \l3 "4.3.2 Melter Offgas Treatment Systems}

In the LAW and HLW melters, water is first evaporated from the feed and released to the offgas system as superheated steam. The feed components then undergo chemical reaction and decomposition. During the decomposition process, gases are formed and released into the melter plenum and offgas system. In addition, a fraction of the feed components is directly carried over to the offgas without incorporation in the glass. The solids and semivolatile components are recycled back to the melter from the offgas system to increase the incorporation rate in the glass.

4.3.2.1 Film Cooler and Quencher. Each LAW and HLW melter is provided with a dedicated film cooler and quencher. The gas streams from the melters include steam, air from the bubblers, and various acid gases (e.g., NO_x, HCL, and HF) formed from decomposition of the feed slurry components and entrained feed components. These gases pass through a film cooler that cools the gas by direct injection of air, and a quench scrubber that removes particulate entrained in the gas stream.

The quench scrubbers capture a high percentage of the HCl and HF gases released from the melter. In order to minimize the concentration (and hence corrosion rate) of the acids retained in the LAW scrubber liquor, fresh demineralized water is added to the quencher sump and the sump contents periodically purged back to the LAW Melter Evaporator to increase the incorporation rate for these components in the glass. For the HLW quencher the purge is returned to the HLW receipt tanks.

The purpose of the offgas treatment system is to process offgas such that, when it is discharged to the atmosphere, it does not exceed environmental discharge limits. The system treats the gas stream from the quench scrubbers to remove potentially radioactive entrained aerosols and small particulate, and to decrease the acid gas content.

4.3.2.2 LAW Melter Primary Offgas System. The LAW primary offgas system consists of high-efficiency mist eliminators (HEME), a selective catalytic reduction (SCR) unit for treating the nitrogen oxides (NO_x), heat exchangers, and a condenser.

A pair of HEMEs is provided for each LAW melter. One HEME is in operation while the second unit is in standby mode or is being washed. The HEMEs remove approximately 99% of the radioactivity content off the off-gas stream that is in the form of liquid aerosols. The offgas streams exiting the HEMEs are combined prior to entering the SCR. When the pressure drop across a HEME reaches a pre-determined level, the unit is taken off line and the standby unit brought into service. The HEME then is backwashed with process water to recover its pressure drop. The liquids that result from operation and washing of the HEME are collected in a sump and returned to the LAW melter feed evaporator.

The SCR unit converts the NO_x in the gas stream into nitrogen and water vapor by reaction with ammonia in the presence of a catalyst of alumina impregnated with metal oxide. The off-gas is heated to reaction temperature in two separate heat exchangers. The first of these heat exchangers cools the gas stream exiting the SCR by heat exchange with the off-gas feed, which is pre-heated. Dilution air is added after this heat exchanger to dilute the concentration of NO_x entering the SCR. The diluted offgas then is raised to reaction temperature in a second heat exchanger.

The gas stream exiting the SCR heat exchanger is further cooled in the LAW offgas condenser. This unit condenses water vapor and significantly reduces the level of radioactivity in the offgas by removing tritium from the offgas as tritiated water. The liquid stream from the condenser is collected and combined with other offgas liquid effluents in the shared active condensate tanks for subsequent transfer to the central effluent handling area of the TWRS-P Facility. The offgas from the condenser is further treated in the secondary offgas system.

4.3.2.3 HLW Melter Primary Offgas System. The HLW primary offgas system consists of a HEME, a high-efficiency metal filter (HEMF), an iodine adsorption unit, a condenser, and a wet scrubber. The function of the HEME is the same as for the LAW system. However, the 99% efficiency of the HEME is not sufficient for the HLW offgas. The offgas is therefore passed through the HEMF, which is capable of achieving a much higher efficiency of particulate removal than the HEME. The offgas exiting the HEME is heated to well above its dewpoint to prevent condensation and then passed through the HEMF. The liquids resulting from HEME operation, and from washing of the HEME and the HEMF, collect in a sump and are returned to the HLW feed vessel.

There is a potential for a significant quantity of iodine-129 present in the HLW offgas based upon the HLW feed specifications (DOE 1996). Because iodine exists as a gas, it is not removed by either the HEME or the HEMF. A dry adsorption unit is used to remove over 98% of the iodine gas. The sorbent bed of the unit, either silver nitrate-impregnated silica gel or silver-exchanged zeolite, is disposed of as a solid waste.

Following iodine adsorption, the HLW offgas stream is treated in the HLW Offgas Condenser, which removes radioactivity (including tritium) and acid gases from the offgas by condensing water vapor. The condensate is disposed of similar to LAW. The offgas is further treated in the HLW offgas caustic scrubber to remove acid gases and carbon-14. The HLW offgas stream is finally treated in the secondary offgas system.

4.3.2.4 Standby Offgas Systems. As discussed above, a primary offgas system is provided for each melter system (i.e., LAW and HLW melters). As a safety feature, standby LAW and HLW melter offgas systems (referred to as the Aemergency offgas systems@ in the Hazards Analysis Report [HAR] [BNFL 1997d]) are provided to treat the melter offgases in the following cases:

1) Overpressurization of a melter during normal operation, resulting from variation in the offgas generation rate

2) Blockage of a film cooler, quench scrubber, HEME or associated ductwork

3) Shutdown and maintenance of the melter offgas system, when the melter requires ventilation (i.e., melter is not processing waste)

The LAW and HLW melter standby offgas systems are designed to be used infrequently. The primary and secondary offgas ducting for the LAW and HLW melters is designed to withstand surge flows of 50% above normal gas flowrate. When the pressure in a melter rises, its feed is stopped, which normally prevents overpressurization. A standby offgas system for a melter is only activated in case of unusually high pressure.

There is one standby offgas line for each LAW and HLW melter. However, the lines for each type of melter are of the same basic design. Ducts connect the melters to isolation dampers, one for each melter. These dampers isolate the melters from the standby offgas lines during normal operation. The dampers are activated by high-pressure in the melter. Immediately downstream of the dampers, air is injected into the gas streams. The air volume is regulated to limit the temperature of the diluted stream. This cools the gas stream to below the softening point of the entrained glass particulates, to protect downstream equipment.

The diluted gas streams each pass through to a high-efficiency cartridge filter of fine fibers or ceramic. Deposited solids are removed from the filter by backblowing with compressed air after or during use. The pressure drop across the filter is continuously measured during operation to check that the filter is not clogging. If the pressure drop becomes too high, the cartridge is washed. If the pressure drop cannot be recovered by washing, the cartridge is replaced. Particles removed from the filter by backblowing fall down into the base of the vessel, where they are washed out and drain down to a sump vessel that is common to all gas streams for a particular melter type. The sump is monitored for level, and when it is full the liquid is emptied by a fludic pump to the contaminated condensate tank in the central effluent handling area of the facility. After washing, the filters are dried. Glass particles collected in the sump are recycled to the melter feed vessels.

The pressure drop across the standby offgas lines is less than across the corresponding main line. To avoid excessively low pressure in the melter, the streams pass through vortex amplifiers that have process air fed in at varying rates. The vortex amplifier is highly reliable fluidics device (no moving parts) used in BNFL nuclear facilities. The operation is based on the Coriolis effect. The air rates control the pressure drops. These air rates allow the system to stabilize after the pressure surge; a vortex amplifier is used to maintain the melter pressure at the desired level until the original reason for the emergency offgas system being used is corrected. At this point, the isolation damper is closed, and the main offgas system is used again.

After filtration, the streams for a particular melter type combine and rejoin the melters primary offgas treatment system. The LAW stream rejoins the primary stream at the inlet to the LAW offgas condenser and the HLW stream rejoins the main stream at the inlet to the iodine-removal column. Removal of oxides of nitrogen and acid gas takes place downstream.

4.3.2.5 Secondary Offgas Treatment System. The secondary offgas system receives offgas streams from the vitrification offgas treatment system, reverse flow diverter exhaust, pulse jet mixer exhaust, and process vessel vent. A combined reverse flow diverter exhaust, pulse jet mixer exhaust, and process vessel vent stream is passed through one of two HEMEs to remove entrained droplets and particulate. The HEMEs work on a duty-standby basis, and each HEME has inlet and outlet sealpots to allow isolation for maintenance and replacement purposes. The HEMEs require routine washing to remove the buildup of particulates. The effluent generated from the washing operation is recycled to the LAW feed evaporator. The treated stream is then combined with the combined HLW and LAW primary offgas streams.

The combined offgas stream then is passed through a counter-current scrubbing column to perform a final cleanup (e.g., 4 race acid gases, ammonia, removal) of the offgas and to cool the offgas stream. The scrubbing column is a packed column and is provided with an integral sump to collect scrubber liquor. The cooling coils are supplied with chilled water. Liquor is recirculated to the top of the scrubbing column. Fresh makeup water is added to the top of the column and the sump tank overflows to a collection vessel.

After leaving the scrubbing column the offgas passes through a heater where the gases are heated to above their dewpoint to prevent condensation within downstream high efficiency particulate air (HEPA) filters. The heater is electrically powered, with spare elements installed to provide redundancy. After heating, the offgas passes through primary and secondary HEPA filters and then through one of two exhaust fans before discharge to atmosphere.

4.3.2.6 Melter Offgas Systems Interfaces and Design Criteria. The melter offgas treatment systems interface with the following systems:

1) Integrated control system - provides process monitoring and control

2) Chilled water system - provides cooling of the HEMEs

3) Process air system - provides air for the HEMF and backblowing air for the emergency offgas HEPA filters

4) Instrument air system - provides air for damper control and operation of the vortex amplifiers

5) High-pressure steam system - provides steam for seal pot ejectors

6) Demineralizer water system - provides water to the HEME, HEME seal pots, and scrubbers

7) Electrical system - provides power to the scrubber recirculation pump motor, HEPA preheaters, offgas extractor and air dilution fans, and vortex amplifier air preheaters.

The melter offgas treatment systems are not designated as Design Class I or II.

4.3.3 Process Vessel Vent System{tc \l3 "4.3.3 Process Vessel Vent System}

The process vessel vent system routes the gaseous discharge from various vessels to the secondary off-gas treatment system. The process vessel vent system is not designated as Design Class I or II.

4.3.4 Water and Steam Systems{tc \l3 "4.3.4 Water and Steam Systems}

This section provides descriptions of the TWRS-P Facility water and steam systems. For each system the function, major components, safety features, and system interfaces are discussed.

4.3.4.1 Process Water System. The 200 East Area raw water system is to be extended by DOE to the TWRS-P Facility site. The water quality from this system satisfies the contaminates limits for bodies of surface water covered by the *Clean Water Act* (*TWRS Privatization Phase 1 Raw and Potable Water Service Engineering Study,* Shord 1996). The TWRS-P Facility process water storage tank receives raw water from this extension. The raw water is treated at the TWRS-P Facility with the following chemicals:

1) NaOH to neutralize the acidity
2) A biocide to control organic material
3) A corrosion inhibitor.

The process water system is located in the water treatment facility adjacent to the process building. The process water system consists of the following components:

1) Water treatment chemical day tanks
2) Chemical metering pumps
3) Chemical area flow sump pump
4) Process water storage tank
5) Process water feed pumps
6) Process water day tank
7) Process water circulation pumps
8) Water softening package
9) Demineralizer package.

Process water feed pumps deliver water from the process water storage tank to the boilers of the high-pressure steam system, the cooling tower, the chilled water system, and process water users in the process building. In this building, the process water is collected in a day tank and then circulated to the users by process water circulation pumps.
Pressure relief valves are provided at discharge of the chemical metering pumps to prevent pressure buildup resulting from inadvertent valve closure. Eye wash and safety showers are provided in the chemical handling area for personnel protection.

In addition to the users of process water identified above, interfaces between the process water system and other systems include:

1) Integrated control system - provides control and monitoring of equipment in the process water system

2) Demineralized water system - process water is further treated by this system to supply demineralized water to the process building and cold chemical makeup

3) Electrical system - provides power to pump motors (e.g., the motors for the feed, metering, circulation, and sump pumps) and valve motors.

The process water system is not designated as Design Class I or II.

4.3.4.2 Cooling Water System. The cooling water system transfers heat from equipment coolers to a multicell mechanical draft cooling tower. The system uses a secondary loop to provide isolation from contaminated areas. The primary and secondary loops are thermally coupled by two full-capacity heat exchangers.

The open circuit primary cooling water system loop comprises three half-capacity pumps, the cooling tower, a chemical feed system, a standby sand filtration system, piping, valves, and instrumentation and controls. Sodium hypochlorite biocide is fed into the cooling water system primary loop by the chemical feed system. Cooling tower blowdown is sent to the nonactive effluent tank. Equipment in nonactive areas is supplied with cooling water from the primary loop. This includes air compressors, secondary loop main heat exchangers, chillers, and standby diesel generators.

Three half-capacity pumps circulate water through the secondary system. The secondary loop includes a chemical addition tank that allows manual addition of a corrosion inhibitor and pH control chemicals. Sample connections on both the primary and secondary loops facilitate water sampling for quality analysis.

Some critical items require a backup cooling water supply in the event of cooling water system failure. This backup supply is from the chilled water system discussed below.

The cooling water system provides cooling water to the following systems and components:

1) Air compressors
2) Condensate system
3) Process equipment on the secondary loop main heat exchangers
4) Chilled water chiller condensers
5) Standby diesel generators
6) High-pressure steam blowdown package.

In addition to the users of cooling water identified above, interfaces between the cooling water system and other systems include:

1) Integrated control system - provides control and monitoring of the cooling water systems, including operation of control valves and pumps

2) Process water system - provides makeup for closed loop cooling tower water to replenish evaporative losses and blow down

3) Demineralized water system - provides makeup water for the secondary loop of the cooling water system

4) Instrument air system - provides air for operation of control valves

5) Low-pressure steam system - steam is admitted into the cooling tower basin to prevent freezing during winter startup and low-load operation

6) Electrical system - provides power to the primary and secondary cooling water system pumps and valve motors and the cooling tower fans.

The cooling water system is designated as Design Class III.

4.3.4.3 Chilled Water System. The chilled water system is a closed loop system that supplies chilled water to various air handling unit cooling coils and equipment coolers. This includes various process heat exchangers, vessels and columns in the pretreatment area, and LAW melter cells and HLW melter cells (HLW/LAW option). The system comprises chillers, pumps, heat exchangers, expansion tanks, chemical feed tanks, air separators, piping, valves, and instrumentation and controls. The major components (e.g., chillers, heat exchanges, and pumps) are located in service building chiller area.

The chilled water system is the primary-secondary circuit type. The primary chilled water circuit consists of three half-capacity chillers and two full-capacity recirculation pumps. The secondary circuits are used to reduce the power consumption from pumps and prevent possible contamination from process equipment. Plate heat exchangers are used to separate the primary circuit from the process area secondary circuits. Seven secondary circuits serve chilled water to the following users:

1) Pretreatment process area
2) LAW process area
3) HLW process area (HLW/LAW option).
4) Process building C2 supply air handling units
5) Process building C2 recirculation air handling units
6) Process building C5 recirculation air handling units
7) Support building C1 supply air handling units.

The chilled water pumps supply corrosion-inhibited demineralized water in a closed-loop piping distribution system to cooling coils in air handling units, building supply air units, and facility equipment coolers. The chilled water system has sufficient capacity to meet cooling loads during normal facility operation, startup, and shutdown conditions. Three chillers can be operated simultaneously when the demand is unusually high. Chillers are equipped with refrigerant pressure relief valves mounted on the evaporator and cooler.

In addition to the equipment listed above, which is cooled by the chilled water system, interfaces between chilled water system and other systems are:

1) Integrated control system - provides the distributed control and instrumentation data communications network to support the monitoring and control of interfacing facility systems

2) Facility air system - provides air for cleaning

3) Instrument air system - provides air for operation of control valves

4) Demineralized water system - supplies makeup water for the chilled water system

5) Electrical system - provides power to chillers, pump and valve motors, and instrumentation.

The chilled water system is not designated as Design Class I or II.

4.3.4.6 HVAC Hot Water System. The HVAC hot water system is a closed-loop hot water system that supplies hot water to air handling unit heating coils and room unit heaters. It comprises two full-capacity hot water generators (using a steam-to-hot water heat exchanger), hot water recirculation pumps, an expansion tank, air separator tank, chemical feed tank, piping, valves, and instrumentation and controls. The major components are located in the service building. The air handling units and room unit heaters are located the buildings and rooms serviced.

The HVAC hot water system provides heating water to the following equipment:

1) Service building air handling unit heating coil

2) Wet chemical storage building air handling unit heating coil

3) Service building chiller room unit heaters

4) Administration building office air handling unit heating coil

5) Empty canister area air handling unit heating coils

6) Melter assembly area air handling unit heating coil

7) Process building C2 area (see Section 4.3.6.1, AProcess Building HVAC@) air handling unit heating coils

8) Glass former building area unit heaters.

Two full-capacity hot water recirculation pumps deliver the corrosion-inhibited demineralized water in a closed-loop piping distribution system to the heating coils in air handling units and room unit heaters and to the hot water generator, air separator, and expansion tank, then back to the pump suction.

Each hot water generator has individual integral temperature controls to automatically control the hot water outlet temperature. The hot water outlet temperature is held constant by controlling the amount of low pressure steam admitted to the hot water generator. Condensed steam is drained back to the condensate return piping.

All pressure vessels, coolers, and heat exchangers are provided with pressure and thermal relief valves.

In addition to the equipment listed above, which is heated by the HVAC hot water system, interfaces between the HVAC hot water system and other systems include:

1) Integrated control system - provides the distributed control and instrumentation data communications network to support the monitoring and control of interfacing facility systems.

2) Facility air system - provides air for maintenance of the air handling unit heating coils

3) Instrument air system - provides air for operation of control valves

4) Demineralized water system - supplies makeup water to the HVAC hot water system

5) Low-pressure steam system - supplies heating steam to the HVAC hot water generators

6) Condensate system - receives the condensate drainage from the HVAC hot water generators

7) Electrical system - provides power to pump and valve motors.

The HVAC hot water system is not designated as Design Class I or II.

4.3.4.7 High-Pressure Steam, Low-Pressure Steam, and Steam Condensate System. The high-pressure steam system is located in the steam facility building. The high-pressure steam system consists of two half-capacity continuously operating boilers, a deaerator package, a blowdown package, and a piping distribution network. A third half-capacity boiler is provided as standby. The high-pressure steam system provides steam to the following:

1) The low-pressure steam system
2) The ejectors in the LAW, HLW (HLW/LAW option), and the pretreatment areas
3) The deaerator package.

The low-pressure steam system originates at the reduction station in the steam facility building and provides the steam supply to the end users in the process building. The low-pressure steam system consists of a pressure reducing station and a piping distribution network. The low-pressure steam system provides steam to the following facilities:

1) LAW feed evaporator reboiler
2) Cesium nitric acid recovery evaporator
3) Technicium nitric acid evaporator
4) Evaporator vessel
5) Melter feed evaporator reboiler
6) Concentrate collection tanks
7) HVAC hot water generators in the process and service buildings
8) HVAC humidifiers in the process and administration buildings

The steam condensate and feed system is located in the south end of the pretreatment bulge zone and the steam facility building. The condensate collection/flash tank is located at the 7-m (23-ft) elevation and the remaining components of the system are located at grade elevation (0 meters). The steam condensate and feed system provides the following functions:

1) Collects condensate from low-pressure steam users

2) Serves as a heat source for the process heat exchangers

3) Treats the condensate in condensate collection/flash tank with a neutralizing amines solution

4) Treats the boiler feed downstream of the deaerator with a catalyzed sodium sulfite solution.

Nonactive low-pressure steam condensate is collected in the condensate collection/flash tank. The header to tank is equipped with a radiation monitor. On detecting a high radiation level, the condensate feed is redirected from the condensate collection/flash tank to the process condensate system. The condensate collection/flash tank is equipped with level and pressure instrumentation. The flash steam discharge line is equipped with a modulating pressure valve to maintain the required pressure in the tank. The steam condensate is returned to the stream boiler feed makeup vessel.

Safety features of the high-pressure steam, low-pressure steam, and steam condensate systems include pressure relief valves on each boiler, deaerator package, and on the steam headers; pipe insulation; automatic isolation of steam system in the event of pipe failure; and radiation monitoring of the nonradioactive condensate tank.

The following is a summary of the system interfaces for the high-pressure steam, low-pressure steam, and steam condensate systems.

1) Process water - provides boiler feed makeup

2) Instrument air - provides power for operation of control valves

3) Floor drain system - receives boiler floor drain discharges in the steam facility building

4) Cooling water system - provides cooling water to the boiler blowdown package

5) Fuel oil system - provides fuel for each boiler

6) Treated Effluent Disposal Facility - receives condensate feed from tank for processing (*TWRS Privatization Phase 1 Liquid Effluent Transfer Systems Engineering Study,* Parazin 1996)

7) Electric power - provides power for the boilers, deaerator package, condensate transfer pumps, diesel fuel pumps, and valve motors.

The high-pressure steam, low-pressure steam, and steam condensate systems are not designated as Design Class I or II.

4.3.4.8 Potable Water System. The 200 East Area potable water system is to be extended by DOE to the TWRS-P Facility site. This system provides filtered and chlorinated water that meets state and Federal standards (Shord 1996). Potable water from this extension is routed to a storage tank located adjacent to the water treatment building. The potable water from the storage tank is pumped to the users by potable water circulation pumps. The pumps are designed to deliver potable water to the lavatory facilities, eyewash stations, safety shower, and miscellaneous potable water users. Tie-in of potable water to nonpotable process lines is not conducted and the potable water system is protected by approved backflow preventers.

The potable water system is not designated as Design Class I or II.

4.3.5 Air and Vacuum Systems{tc \l3 "4.3.5 Air and Vacuum Systems}

This section provides descriptions of the TWRS-P Facility air and vacuum systems. For each system the function, major components, safety features, and system interfaces are discussed. In addition, for those systems designated as Design Class II, the safety criteria and implementing codes and standards contained in the SRD are presented.

4.3.5.1 Compressed and Instrument Air Systems. The compressed and instrument air systems are located in the service building attached to the process building. The systems provide clean and dry air to the pretreatment, LAW, HLW (HLW/LAW option), and other support facilities. The compressed air system includes four centrifugal compressors that feed two air receivers. From the receivers, the air is dried by two refrigerated air dryers. The air distribution system is divided into two main systems for critical and noncritical use.
The instrument air system receives air from the compressed air critical air supply. Desiccant tower dryers with a prefilter and an after-filter provide additional drying of the instrument air. Local instrument air receivers are located in each building served.

The compressed and instrument air systems interface with the following:

1) Integrated control system - provides monitoring and control
2) Process systems - use compressed for purging and mixing
3) Cooling water system - cools compressors and dryers
4) Electrical system - powers the compressors and the refrigerated dryers.

Portions of the compressed and instrument air system are designated as Design Class II. The design, construction, and operation of the Design Class II portions of the compressed and instrument air systems are in accordance with the SRD Safety Criteria identified in Table 4-18.

Table 4-18. SRD Safety Criteria Applicable to Design Class II Air Systems

SRD Safety Criterion	Subject[1]
4.1-4	SSCs shall be designed to withstand the effects of natural phenomena without loss of safety function.

4.4-3	Design Class II systems and components shall be designed and constructed to permit testing, inspection, and maintenance throughout its operating life to verify continued acceptability for service with an adequate safety margin.
4.4-15	Design Class II instrument air systems shall be designed to ensure operability under normal and accident conditions. The design shall permit appropriated periodic pressure and functional testing to assure: 1) Air quality 2) Structural integrity of its components 3) The operability and the performance of active components of the system 4) System operability as a whole.
4.4-16	Instrument air supplied to Design Class II equipment shall be clean, dry, and oil free. The instrument air shall be free of all corrosive and hazardous gases which may be drawn into the system.

Note: [1] Refer to the *Safety Requirements Document* (BNFL 1997g) for the complete wording of the listed Safety Criteria.

The Design Class II portions of the TWRS-P Facility air systems are designed to the following implementing codes and standards:

1) ASME B31.3, *Process Piping*

2) ASME Section VIII, *Boiler and Pressure Vessel Codes, Rules for Construction of Pressure Vessels*

3) ASME PTC 9, *Performance Test Codes, Displacement Compressors, Vacuum Pumps and Blowers*

4) ISA S7.0.0, *Quality Standard for Instrument Air*.

4.3.5.2 Breathing Air System. The breathing air system is located in the service building adjacent to the southwest side of the process building. The breathing air system consists of the following equipment:

1) Compressor air inlet filter
2) Centrifugal, oil-free compressor
3) Air purifier with particulate afterfilter
4) Air receiver with relief valve
5) Two banks of air bottles with regulators and relief valves
6) Piping and valves.

Compressed air is purified, passed through a particulate afterfilter, and distributed throughout the facility. A backup air supply is provided by two banks of bottled air that are automatically placed in service in the event of compressor failure or loss of electrical power. The breathing air system is equipped with pressure relief valves to prevent equipment damage resulting from overpressurization.

The breathing air system interfaces with the following systems:

1) Integrated control system - provides monitoring and control

2) Cooling water system - provides cooling water to the breathing air compressor for use in the intercooler, oil cooler and aftercooler

3) Electrical system - provides power for the compressor motors and the refrigerated dryers.

The breathing air system is not designated as Design Class I or II.

4.3.5.3 Vacuum System. The vacuum system is located in the process building. The vacuum system provides a header and connections to supply air flow to the following:

1) Radiation air monitoring equipment and air samplers throughout the process building

2) Radiation air monitoring equipment and air samplers in the duct and stack sample systems.

The vacuum system consists of two vacuum blower packages and the piping distribution network.

The vacuum blowers are provided with relief protection on the suction and discharge. Silencers are provided to minimize noise. Blower discharge is routed through HEPA filters to minimize the potential for personnel contamination.

The vacuum system interfaces with the following:

1) Integrated control system - provides for alarm circuits and remote blower operation
2) Instrument air system - provides air for operation of control valves
3) Process building exhaust - provides HEPA-filtered discharge of the blowers
4) Electrical system - provides power for vacuum blowers.

The vacuum system is not designated as Design Class I or II.

4.3.6 Heating, Ventilating, and Air Conditioning Systems{tc \l3 "4.3.6 Heating, Ventilating, and Air Conditioning Systems}

This section provides descriptions of the TWRS-P Facility HVAC systems for the process building and other buildings (i.e., nonprocess building HVAC). For each HVAC system the function, major components, safety features, and system interfaces are discussed. In addition, for those systems designated as Design Class II, the safety criteria and implementing codes and standards contained in the SRD are addressed.

4.3.6.1 Process Building HVAC. The waste treatment facility ventilation system is designed to provide pressure gradients between confinement zones in which the air flow cascades from the areas of low or no contamination to areas with the greatest potential of contamination. The contamination area designations identified for the design of the ventilation systems consist of the following areas:

C1 Areas: Offices and equipment rooms in adjoining buildings (the HVAC system for this area is separate from the process building HVAC)

C2 Areas: Operating areas, equipment rooms, stores, access corridors, and facility rooms

C3 Areas: Normally unoccupied areas that are accessed for maintenance activities

C4 Areas: Decontamination caves, washdown cells, and posting stations

C5 Areas: Pretreatment cells, cesium powder handling line (LAW-Only option), melter cells, pour and cooling cells, buffer store, welding and lidding cell, and filter caves.

The ventilation fans for the process building are:

1) Vessel vent extract and melter offgas fans
2) C5 extract fans
3) C3 extract fans
4) C2 supply air handling units and extract fans
5) LAW/HLW 60-day store C2 supply/extract fans.

Air is drawn from C2 areas and cascaded through C3 areas into C4 or C5 areas, or alternatively extracted from the C3 areas by the C3 extract system. When there is no cascade to C3 from C2 areas, the C2 extract system maintains a nominal negative pressure to atmosphere.

Air is supplied to the C2 areas and corridor by the C2 supply system, which consists of air handling units operating on 100% outside air (i.e., no recirculation). Each of the LAW store and HLW store areas have a dedicated air handling unit operating on 100% outside air. The C2 extract fans discharge the C2 rooms and the LAW /HLW store areas to atmosphere above roof level. The C3 extract fans exhaust the C3 areas and pass the air through a stack monitoring system before discharge to atmosphere via the stack.

The process vessels are maintained at a pressure less than the surrounding process cells by the process vessel ventilation system. The air exhausted from the process vessels, pulse jet mixers, and reverse flow diverters (RFD) pass through a HEME to separate entrained droplets. The HEME discharges the liquid water to collection vessels for recycling to the pretreatment process.

The exhaust air then is combined with the primary offgas from the LAW melters and the HLW melter. The combined offgas stream passes through a water scrubber and is filtered using two stages of HEPA filters. Vessel vent/melter offgas fans and C5 extract fans exhaust the C4 and C5 areas through stack monitoring systems before discharging to atmosphere via the stack.

The HVAC system provides cooling for the heat loads within the process building. Areas within the building that have requirements for heating and/or cooling which are not met by the C2 supply ventilation system are provided with local heaters and/or coolers.

The C5 extract portion of the process building HVAC system is designated as Design Class II. This includes the ductwork stack, fans, power, and control but not the filters. The C5 extract portion of the process building HVAC system is designed, constructed, and operated in accordance with SRD Safety Criteria Identified in Table 4-19.

The Design Class II portions of the process building HVAC system are designed to the following implementing codes and standards:

1) ARI 670, *Fans and Blowers*
2) ASME N509, *Nuclear Power Facility Air Cleaning Units and Components*
3) ASME N510, *Testing or Nuclear Air Cleaning Systems*
4) ASME PTC 11, *Performance Test, Codes, Fans*
5) UL 586, *UL Standard for Safety High-Efficiency, Particulate, Air Filter Units*.

Table 4-19. SRD Safety Criteria Applicable to Design Class II HVAC

SRD Safety Criterion	Subject[1]
4.1-4	SSCs shall be designed to withstand the effects of natural phenomena without loss of safety function.
4.4-3	Design Class II systems and components shall be designed and constructed to permit testing, inspection, and maintenance throughout their operating life to verify continued acceptability for service with an adequate safety margin.
4.4-6	The design shall ensure operability under normal and accident conditions. The design shall permit appropriate periodic inspection and pressure and functional testing to address: 1) The structural and leaktight integrity of its components 2) The operability and the performance of active components of the system such as fans, filters, dampers, pumps, and valves 3) System operability as a whole.
4.3-7	Radiological and chemical exposure to control room operators shall be limited to 5 rem whole body, 30 rem skin beta, and the chemical limits of SRD Safety Criterion of 2.0-2 if credit is taken for operator action to satisfy the offsite exposure standards of SRD Safety Criteria 2.0-1 or 2.0-2.
4.4-7	Ventilation systems and offgas systems must be provided where necessary to control radiological and chemical material releases and the generation of flammable and explosive gases during normal and off-normal conditions.
4.5-3	Fire confinement should be achieved through use of passive barriers, fire and smoke dampers, and exhaust fans.

Note: [1] Refer to the *Safety Requirements Document* (BNFL 1997g) for the complete wording of the listed Safety Criteria.

4.3.6.2 Nonprocess Building HVAC System. The design of the nonprocess building HVAC systems are based on the location of building and the function of the building. HVAC systems are provided to serve following nonprocess buildings:

1) Administration building
2) Administration building control room
3) Service building shop area
4) Empty canister storage and inspection
5) Melter assembly area
6) Glass former building
7) Wet chemical storage building
8) Main electrical room (service building)
9) Pump house

10) Steam facility
11) Water treatment building
12) Sewage treatment facility.

A variable air volume system is designed to provide conditioned air to administration building and service building shop area. This type of system allows a central air handling unit to serve multi-zones with better control in room temperature and reduces heating and cooling consumptions. A constant air volume system is designed to provide conditioned air to the melter assembly area, canisters storage/inspection area, wet chemical storage, and the electrical building.

The air handling unit consists of an economizer, low-efficiency filters, high-efficiency filters, a hot water heating coil, a chilled cooling coil, and a supply fan. The electrical building air handling unit does not use a hot water coil because of its internal heat generation from equipment that is sufficient to maintain the room temperature. The inverter/battery rooms air handling unit use outside air for cooling and a hot water heating coil to provide heating. The air handling unit air supply temperature is controlled by the room thermostat at a set point range by modulating the capacity of cooling coil and heating coil. The air handling unit, uses the economizer for free cooling in minimizing the use of cooling coil. The room differential pressure between the room and outside atmosphere is maintained by balancing the supply and return air flow.

A recirculation system is designed to provide conditioned air to control room area. The HVAC system consists of two full-capacity recirculation units. The unit consists of low-efficiency filters, a chilled water cooling coil and a supply fan. The air supply temperature is controlled by a room thermostat by modulating the capacity of cooling coil to satisfy the worst demand of cooling. A duct-mounted electric heater is installed at each room to temper the air supply to meet the design temperature. The administration building air handling unit supplies makeup air to the recirculation units through a constant flow variable air volume terminal. A differential pressure between the room space and outside atmosphere is maintained by modulating the relief damper and the return air damper connected with the administration building air handling unit. The system also includes a self-contained humidifier. The humidifier is electric-operated with built-in controls.

Exhaust ventilation systems provide ventilation to the service building chiller room, glass former building, and battery rooms.

The ventilation system consists of four, one-quarter capacity roof exhausters. The pump house ventilation system use two, one-half capacity roof exhausters. Automatic wall louvers are interlocked with exhaust fans. Room thermostats start and stop the roof exhaust fans at a range of set points to reduce the amount of heating during winter. Hot water unit heaters are provided to supply heating in general. Electric unit heaters are used in the pump house system. The air supply temperature is controlled by room thermostats by modulating the capacity of heating coil to maintain the room.

Interfaces between HVAC systems and other systems include the following:

1) Integrated control system - provides distributed control and instrumentation data communications network to support the monitoring and control of interfacing facility systems

2) Chilled water system - provides chilled water to the cooling coils in the air handling units

3) Facility air system - provides air for cleaning HVAC coils

4) Instrument air system - provides air operation of control valves

5) Hot water system - provides hot water to the heating coils in the air handling units

6) Facility fire protection system - air handling units provides fire protection by interlocking with smoke detectors and the facility annunciator fire panel

7) Potable water system - provides water to the control room self-contained humidifier

8) Facility low-pressure steam system - provides steam to the administration area humidifier

9) Electrical system - provides power to air handling units, fans, variable air volume terminals, unit heaters, duct heaters, humidifiers, dampers, valves, and instrumentation and control.

The nonprocess building HVAC system is not designated as Design Class I or II. Safety Criterion 4.5-3 of the SRD (BNFL 1997g) is applied to the design of all HVAC systems. This criterion requires the use of passive barriers, fire and smoke dampers, exhaust fans to mitigate the effects of fire. The need for these features is defined by the fire hazards analysis (see Section 4.6.5, AFire Hazards Analysis@).

4.3.6.4 Modifications for Tank 241-AP-106. As part of the BNFL Inc./DOE Part B privatization contract (DOE-RL 1996d), operation of DST 241-AP-106 is transferred to BNFL Inc. The tank is a staging tank for LAW feeds between DOE and the TWRS-P Facility**.** Before the beginning of Part B waste processing operations, tank 241-AP-106 is isolated from the existing AP Farm services by providing the following BNFL Inc.-owned and operated systems and components:

1) Mixer pump
2) Two waste transfer pumps
3) Primary ventilation system
4) Annulus ventilation system
5) Pipeline flushing system
6) Tank instrumentation
7) Electrical distribution
8) Fire protection.

A new service building is located outside the existing AP Tank Farm fence to house the primary and annulus ventilation systems, instrumentation, electrical equipment, and the pipeline flushing equipment.

Four new transfer pipes are routed to the TWRS-P Facility. Two pipes are used for transfer of Envelopes A, B, and C feeds from tank 241-AP-106 to the TWRS-P Facility and returned solids from the TWRS-P Facility to DOE. The remaining two pipes support HLW transfers from a DOE valve pit outside the AP Tank Farm to the TWRS-P Facility. Information on the new transfer lines is provided in Section 4.3.1.1,@ Waste Receipt.@

Information on new structures required to support tank 241-AP-106 operation is provided in Section 4.2.1, ABuilding Description.@ Information on the interfaces needed to ensure safe operation is described in Interface Control Document (ICD-21).

The new mixer pump is located in the riser of the existing central pump pit. The pump is based on existing Hanford project proposals using a special purpose ALawrence@ centrifugal pump configured with two opposing jets to provide the agitation. The existing distribution nozzle in tank 241-AP-106 is removed and modified to allow the pump to be installed.

The two waste transfer pumps are located in a new tank 241-AP-106 transfer pit. The pumps are configured to supply waste to the TWRS-P Facility through either of the two new transfer pipes (see Section 4.3.1.1, AWaste Receipt@). The second pipe routes return tank waste from either of the two transfer pumps back to the DOE facility. The pumps are either long-shaft centrifugal or turbine pumps with a special purpose flangeless connection to the transfer pipework.

The new primary ventilation system is installed on a new concrete pad at the southwest of tank 241-AP-106. The inlet portion of the primary ventilation system is a skid-mounted unit incorporating a heater, prefilter, HEPA filter assembly. This unit is connected to the Tank Riser 10. The extract portion of the primary ventilation system consists of a new double-contained duct, connected to Riser 16 and routed belowground to a new ventilation extract and filter system located in a segregated area of the new 241-AP-106 service building. The extract portion includes demister equipment and a skid-mounted filtration system that includes a heater, prefiltration, and primary and secondary HEPA filtration. Stack instrumentation monitors aerial discharges.

The annulus ventilation system includes a extract duct connected into the existing annulus duct belowground north of Riser 5. The duct is routed to a skid-mounted filter and extract fan located in a segregated area in the new tank 241-AP-106 service building. Continuous air monitoring equipment is provided on the annulus extract before filtration to monitor for releases of contamination into the annulus system. The system includes a heater, prefiltration, and primary and secondary HEPA filtration. The filtered annulus ventilation extract joins the primary extract before discharge via a new stack. Annulus filtration equipment is duplicated for maintenance and standby operation.

The power source for the tank 241-AP-106 electrical system is provided by DOE (Refer to ICD-21).

To minimize upsets to the DST monitoring system during construction, BNFL Inc. will rely on the existing tank monitoring instrumentation to the extent practicable. The new monitoring system reroutes the tank 241-AP-106 instrumentation formats to the new control building with the exception of the leak detection pit instrumentation, which remains under DOE control. Structural thermocouple signals, are routed from a new BNFL Inc. provided serial link in the AP-271 instrument building.

The tank 241-AP-106 operational parameters are monitored and controlled by BNFL Inc. monitoring and control equipment. Mixing of the tank waste prior to transfer to the TWRS-P Facility is considered as part of the transfer process. New instrumentation is installed as required to maintain the tank within its safe operating envelope during waste transfer to the TWRS-P Facility.

Automatic fire alarms and a reaction automatic fire sprinkler system are installed in the service building. The fire alarm system includes audible and visual warning devices, pull stations at each exit, smoke detection, sprinkler system water flow alarm, and control valve tamper supervision. Fire alarms are transmitted the Hanford Fire Department and to the TWRS-P Facility main control room. Exits are provided in accordance with *Life Safety Code,* NFPA 101.

The automatic sprinkler system is supplied from a raw water flush tank that is sized to cover a minimum heel volume to meet sprinkler water requirements. A new fire hydrant is installed local to the service building to provide hose coverage of no more than 90 m (300 ft) to any potion of the building.

Raw water is provided for pipe flushing and facility wash down. A new pipe will connect to the existing 200 East Area raw water system. The raw water is filtered and provided with double backflow protection. Filtered raw water is stored in a flush tank outside the service building. The tank is freeze-protected and heated for process flushing. A new flushing pump draws water from the tank and feeds a new line to the new transfer pit were it tees into the new transfer pipes. This line is provided with double backflow protection in the new pump pit.

The ventilation, piping, pumping, electrical, fire protection, and instrumentation and control systems for the tank 241-AP-106 modifications are not designated Design Class I or II.

4.3.7 Fire Protection System{tc \l3 "4.3.7 Fire Protection System}

This section discusses the fire protection features provided for the TWRS-P Facility. The fire protection provided for the new tank 241-AP-106 structures are discussed in Section 4.3.6.4, AModifications for tank 241-AP-106.@ For the TWRS-P Facility, the 200 East Area fire suppression distribution system is to be extended to the facility site. To prevent the contamination of fire suppression system component or the spreading of contaminates during fire suppression activities, the water quality of the fire suppression distribution system meets the contaminate limits for bodies of surface water covered by the *Clean Water Act.* Particles greater than 3 mm (0.125 in.) are strained to prevent damage to pumps. The 200 East Area fire suppression distribution system also meets the requirements of *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* NFPA 24 (Shord 1996).

The TWRS-P fire protection system performs the following functions:

1) Monitors the suppression system status, detects and locates fires, and provides operator indication of the fire location

2) Provides automatic and/or manual capability to extinguish fires in any facility area to protect site personnel and limit fire damage

3) Aids in minimizing exposure to personnel and releases to the environment of radioactivity of hazardous chemicals as a result of a fire.

The fire protection system consist of several subsystems for fire detection and alarm, fire water supply system, and automatic and manual fixed fire suppression systems.

4.3.7.1 Fire Detection and Alarm System. The fire detection alarm system is designed to detect and locate fires, provide alarms, inform the control room of the fire location, and monitor the fire protection system status. The system also monitors the status of the fire protection system and annunciates the suppression system actuations. Manual fire alarm boxes (pull stations) are provided in accordance with *National Fire Alarm Code,* NFPA 72. The fire detection and alarm system also transmits signals to the Hanford Fire Department.

4.3.7.2 Fire Water System. The fire water system includes fire water storage tanks, pumps, piping, valves, and other components needed to deliver water to fire hydrants, standpipes, and fixed fire suppression systems. The two fire water storage tanks located outdoors, each contain a two hour supply to the expected largest demand. The fire water storage tanks are permanently connected to the fire pump suction. Each pump is full-capacity and can take suction from either or both tanks. The lead fire pump is electric motor-driven and the second pump is diesel engine-driven. A motor-driven jockey fire pump is provided to maintain the fire main header pressure.

Fire protection water is distributed by an underground yard main loop with sectionalizing valves. The yard main loop includes a building interior header that distributes water to fire suppression systems within the facility buildings. Piping and valves located outdoors are buried or are heat traced and insulated for freeze protection if exposed. Sprinkler and standpipe systems are supplied by connections from the yard main. Each connection has a post-indicating valve that is locked open or electrically supervised.

4.3.7.3 Automatic Fire Suppression Systems. Fixed automatic fire suppression systems are provided in selected building fire areas based on the fire hazard analysis (FHA) (see Section 4.6.5, AFire Hazards Analysis@). The selection of the type of system for each facility area is governed by the guidance of *Standard for Facilities Handling Radioactive Materials,* NFPA 801, with consideration of the effects of fire suppression agents on personnel and sensitive equipment. Water systems are preferred but the use of automatic water suppression systems for fire fighting in radiation areas is minimized because of the possible spread of contamination. Clean agent (gaseous; non-Hanlon) extinguishing systems are provided for protection of electrical equipment rooms where a water system is deemed not suitable. Halon fixed flooding systems are not used because of environmental concerns.

4.3.7.4 Manual Fire Suppression Systems. Fixed manual fire suppression are provided based on the results of the Fire Hazard Analysis (Section 4.6.4, AFire Hazards Analysis@). Facility areas that have an automatic suppression system also have manual backup fire suppression capability.

Hydrants are provided on the yard main in accordance with *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* NFPA 24, at intervals of up to about 91 m (300 ft). The hydrants provide hose stream protection for every part of each building and two hose streams for every part of the interior of each building not covered by standpipe protection. Hose hydrants are provided in accordance with NFPA 24. They are located at intervals of not more than 305 m (1000 ft) along the yard main. NFPA 14 Class III standpipes and hose stations are provided for buildings in accordance with *Standard for the Installation of Standpipe and Hose Systems,* NFPA 14 requirements. Wet standpipe systems are used.

Hose stations are located to facilitate access for fire fighting. Alternative hose stations are provided in areas where fire could block access to a single hose station serving that area. Each hose station has no more than 30.5 m (100 ft) of 40 mm (1.5 in.) diameter woven jacket-lined hose. One or more fixed or adjustable spray nozzles are provided at each station. No-shock nozzles are provided for use in areas where electrical shock hazard exist. Nozzles meet the requirements of *Spray Nozzles*, NFPA 1964 and have shutoff capability.

The HEPA filters in the ventilation system, where required, are provided with manually actuated water spray suppression system. These systems consist of piping from a normally closed fire water supply valve to water deluge ports or nozzles within the filter housings.

Portable fire extinguishers, in accordance with *Standard for Portable Fire Extinguishers,* NFPA 10, are installed in easily accessible locations along routes of travel in the vicinity of doors and hallways and near (but outside) radiation areas for use in radiation areas.

The fire protection system interfaces with the following systems:

1) Integrated control system - provides the distributed control and instrumentation data communications network to support the monitoring and control of facility systems and, interfaces with the fire protection system main and local control panels

2) Raw water system - provides an alternate water source to the fire protection system and can refill the fire water storage tanks

3) Facility air system - provides air for maintenance of the fire pumps

4) Instrument air system - provides air for operation of control valves and for pressure maintenance of the pre-action or dry pipe systems

5) Fuel oil system - provides fuel oil for the diesel engine-driven fire pump

6) Waste water system - provides a drainage and disposal path for firewater discharged when the fire protection system is tested and from fire suppression activities

7) Electrical system - provides power for the fire pump and jockey pump motors, valves, panels, and instrumentation.

The fire protection system is not designated as Design Class I or II. The design, construction, and operation of the fire protection system are in accordance with the SRD safety criteria identified in Table 4-20.

Table 4-20. SRD Safety Criteria Applicable to the Fire Protection System

SRD Safety Criterion	Subject[1]
4.5-1	Two reliable and separate water supplies of adequate capacity for fire suppression shall be provided.

Table 4-20. SRD Safety Criteria Applicable to the Fire Protection System

SRD Safety Criterion	Subject[1]
4.5-3	Confinement of a fire to its origin should be achieved through use of passive barriers fire and smoke dampers, exhaust fans, and drainage pumps to prevent migration of gases, hot combustion products, and flammable liquids to new areas.
4.5-4	Automatic fire extinguishing systems should be included in all areas subject to loss of Design Class I systems, significant fire hazards, or unacceptable program interruption, as determined by the fire hazards analysis.
4.5-5	Redundant, primary and secondary, fire protection systems shall be provided in areas where Design Class I systems and components are vulnerable to fire damage and where no redundant safety capability exists outside the fire area.
4.5-6	Life safety features are incorporated including means to notify and evacuate building occupants in the event of a fire.
4.5-7	The facility shall include a fire protection system to detect a fire and activate an alarm so that measures for confinement and suppression of the fire and personnel evacuation may start promptly. The detection system shall provide means to summon the Hanford Site Fire Department and shall function without offsite power.
4.5-8	The facility design shall provide for intervention by the Hanford fire department, such as an interior standpipe system.
4.5-10	Unique features of the facility not addressed by industry codes and standards are protected by isolation, segregation, or the use of special fire control systems.
4.1-11	Fire protection systems are designed such that their inadvertent operation, inactivation, or failure of structural stability will not result in the loss of a Design class I function.

Note: [1] Refer to the *Safety Requirements Document* (BNFL 1997g) for the complete wording of the listed Safety Criteria.

The fire protection system is designed to the following implementing codes and standards:

1) NFPA 214, *Standard on Water-Cooling Towers*

2) DOE G-440.1, *Implementation Guide for use with DOE Orders 420.1 and 440.1 Fire Safety Program*

3) DOE-STD-1066, *Fire Protection Design Criteria*

4) NFPA 801, *Standard for Facilities Handling Radioactive Materials.*

Other aspects of the TWRS-P Facility fire protection program are addressed in the ISAR sections:

1) Section 4.2, AFacility Description,@ - building design
2) Section 4.6, AISA Methods,@ - fire hazards analysis
3) Chapter 8.0, AFire Safety,@ - programmatic consideration.

4.3.8 Miscellaneous Mechanical Systems{tc \l3 "4.3.8 Miscellaneous Mechanical Systems}

This section provides descriptions of the TWRS-P Facility fuel oil and sewage treatment systems. For both systems the function, major components, safety features, and system interfaces are discussed.

4.3.8.1 Fuel Oil and Transfer. The fuel oil storage and transfer system provides the following functions:

1) Storage of diesel fuel for supply to individual users (boilers, standby diesel generators, and diesel fire pumps). This includes the capability of off-loading diesel fuel from supply trucks.

2) Distribution of diesel fuel from the storage tank to the day tanks for each of the individual users.

The fuel oil storage and transfer system includes the following equipment:

1) Diesel fuel storage tank
2) Unloading pump
3) Two transfer pumps
4) Two diesel fuel day tanks for the boilers
5) Two diesel fuel day tanks for the standby diesel generators.

In addition to the equipment listed above, supplied by the fuel oil and transfer system, are the following interfaces with this system:

1) Control systems - provides such functions as alarm circuits, remote pump operation, and remote tank-level indications

2) Instrument air system - provides for operation of control valves for fuel transfer operations

3) Electrical power - provides power for the unloading pump motor, transfer pump motors, and electrical heat tracing of outdoor piping.

4.3.8.2 Sewage Treatment. The sewage treatment system collects domestic waste from the cafeteria, lavatories, rest rooms, showers, and drinking fountains located in the administration and service buildings. The waste is transferred via gravity drain to the sewage lift station located in the sewage treatment building. Two sewage lift pumps, each capable of pumping the anticipated peak flow of waste, transfer the sewage to a equalization tank. The waste is processed through the sludge aeration tank, clarifier, filter, and chlorine disinfection before discharge to the storm drain.

4.3.9 Electrical Power{tc \l3 "4.3.9 Electrical Power}

The TWRS-P Facility electrical system receives power from the Hanford Site A4-8 230 kV transmission system. This system will be modified by DOE and looped into a new 230 kV substation that will include two 230-13.8 kV transformers. The new substation will be capable of providing up to 40 MW to the two TWRS-P facilities with capability for expansion (*Design Requirements Document for the Phase I Privatization Electrical Power System,* [Sing et. al 1996]). The electrical power for tank 241-AP-106 is discussed in Section 4.3.7.4, AModifications for tank 241-AP-106.@

4.3.9.1 Normal/Alternate Power. As discussed above, two identical 230-13.8 kV transformers are provided by DOE as offsite power sources. Within the TWRS-P Facility, power will be distributed at the 13.8 kV, 4.16 kV, and 480 V level. Design development in Part B may show that the second medium voltage level (4.16 kV) is unnecessary. This design development may also show that the 13.8 kV voltage level can be eliminated but the 4.16kV level retained making the 4.16 kV a single medium voltage distribution network within the facility.

Within the TWRS-P Facility, power is distributed as Load Groups A and B with each group supplied power from one of the two DOE-supplied 230-13.8 kV transformers discussed above. A normally open bus tie breaker can connect Load Groups A and B. Each of the DOE 230-13.8 kV transformer is expected to be sized to concurrently carry load groups A and B loads. This features enables taking either transformer out of service for repair or maintenance as well as coping with a partial loss of offsite power. The melters are powered at the 4.16 KV level.

4.3.9.2 Standby Power. Standby power is provided on loss of offsite power by onsite diesel generators. The electrical loads provided with standby power include those loads that can tolerate a short power interruption as the diesel generators start and load.

Standby power at 13.8 kV is supplied by three parallel diesel generators to support the LAW melter loads and HLW melter loads (HLW/LAW option). Diesel start and load transfer is by operator action. The 13.8-kV diesel generators and their associated equipment are intended for investment protection and, therefore, are not designated as Design Class I or II.

Standby power at 480 V is provided from a single Design Class II diesel generator. This diesel generator starts and acquires its loads automatically. Automatic transfer switches provide for transfer of the motor control center power sources from the normal source to the 480-V standby source.

4.3.9.3 Uninterruptible Power Supply. Loads that must be provided a continuous source of electric power are powered by a battery-backed uninterruptible power supply. Normally, the uninterruptible power supply is powered from an AC bus that is backed up by a standby power source via a DC rectifier and inverter. Therefore, the incoming power supply to the uninterruptible power supply can be restored within the time limits established for the 480-V standby generator to automatically start and load. The uninterruptible power supply system includes a static inverter, AC static transfer switch, a hardwired maintenance bypass switch, distribution panels, and a step-down transformer as a bypass alternate source of power.

The uninterruptible power supply loads generally are limited to instrumentation loads sensitive to power interruption and emergency lighting but may include other loads/systems as deemed necessary. The uninterruptible power supply loads include the following:

1) Main control system
2) Melter control system
3) Radiological surveillance system
4) Intercom system
5) Stack discharge monitor
6) Effluent discharge monitor
7) Area gamma monitor
8) Alpha/beta-in-air monitor
9) Public address and evacuation system
10) Waste tracking system.

4.3.9.4 DC Power. DC power is available from two batteries (assigned to Load Groups A and B) that are maintained on a continuous float charge by a dedicated charger/rectifier. This charger/rectifier also supplies DC loads during normal operation and during loss of normal power when a standby diesel generator is available. The charger is rated to carry all loads while charging the battery.

4.3.9.5 Cable and Raceway Grouping. Cable raceways are arranged physically, from top to bottom, in accordance with the function and voltage class of the cables, as follows:

1) 15 kV cables
2) 5 kV cables
3) Low voltage power AC and DC cables
4) High-level signal and control cables (120 VAC, 125 VDC)
5) Cables for low-level analog and digital signals.

In order to minimize the potential for electromagnetic interference, the instrument cables carrying low-level analog and digital signals are, to the extent practicable, routed in separate vertical stacks from the 15-kV and 5-kV cables.

A raceway designated for a single class of cable contains only cables of the same class. Cable trays containing low voltage instrumentation cables provide protection against spurious signal sources.

4.3.9.6 Egress, Emergency Escape, and Essential Lighting Systems. This section discusses the lighting systems for the TWRS-P Facility.

Egress Lighting. Via integral self-contained dry battery packs/inverters compose each lighting fixture identified as egress lighting. These fixtures are used for stairways and exit routes. The egress system operates on a nonmaintained basis with the exception for the control room, and the door emergency exits which operate on a maintained basis. A short interruption of supply is acceptable during operation of the changeover switch.

Emergency Escape Lighting. The emergency escape lighting power supply is backed up by the uninterruptible power supply system. The escape lighting fixtures are separate from the normal lighting fixtures and used in the areas, such as the main control room, which are required to sustain the minimum illumination level at all times, including the period of a temporary loss of power.

Essential Lighting. A selected part of the normal lighting operates as essential lighting designed to provide a minimum level of illumination throughout the facility to aid in restoring the facility to normal operation or to aid in safe shutdown. This lighting is powered from a bus backed up by the standby diesel generator and is designated as Design Class II.

4.3.9.7 Grounding System. A ground grid is furnished over the entire facility area to provide for personnel safety and facilities for grounding SSCs. The grounding conductors are of sufficient size to carry the maximum ground fault current. The grounding grid is designed to limit touch and step potentials to safe values under the calculated ground fault conditions.

A main ground grid is made of bare copper no smaller than No. 2 American Wire Gage, buried below the earth surface. Rods used for grounding electrodes are made of iron or steel. Cable risers are brought above grade from the grid at two or more locations near each site structure. All underground connections to the grounding system are made by thermo-welding. Exposed connections and taps are made with pressure-type connectors.

Electrical equipment, building steel, and metal components likely to become energized under abnormal conditions are effectively grounded by direct or indirect connection to the main ground grid. Columns and beams not directly connected to the grounding system are considered to be effectively grounded if they can be traced to a grounded column through a series of metal-to-metal connections.

4.3.9.8 Lightning and Surge Protection. Electrical equipment and lines are protected where necessary with lightning arresters and surge capacitors. In general, lightning arresters are installed where an overhead system changes to an underground system or at the equipment tied to the overhead lines. Lightning protection is installed for all buildings and high structures in accordance with the recommendations of the NFPA 780. The protection system consists of air terminals bussed together and connected to the facility grounding system via down conductors. Down conductors are provided with a suitable clamp-type disconnecting means to enable the checking of the ground resistance.

4.3.9.9 Design Class II Electrical Circuits. Electrical equipment, cable, and circuits identified as Design Class II, are physically separated from other equipment, cables, and circuits to increase their availability during a common mode failure.

Minimum separation distances are patterned after those recommended in IEEE 384-1992, *Standard Criteria for Independence of Class 1E Equipment and Circuits*, for the nuclear safety-related circuits routed in the Limited Hazard Areas (also known as general facility areas for nuclear power facilities). The minimum separation distances used for these areas are based on hazards being limited to failures or faults internal to the electrical equipment or cables.

The TWRS-P Facility design, construction, and operation of the Design Class II portions of the electrical systems and components are in accordance with the SRD safety criteria identified in Table 4-21.

Table 4-21. SRD Safety Criteria Applicable to Design Class II Electrical System

SRD Safety Criterion	Subject[1]
4.1-4	SSCs shall be designed to withstand the effects of natural phenomena without loss of safety function.
4.4-3	Design Class II systems and components shall be designed and constructed to permit testing, inspection, and maintenance throughout their operating life to verify continued acceptability for service with an adequate safety margin.
4.4-11	Design Class II electrical power systems shall be designed to ensure their operability during normal and accident conditions. The design shall provide for periodic inspections and testing.

Note: [1] Refer to the *Safety Requirements Document* (BNFL 1997g) for the complete wording of the listed Safety Criteria.

The Design Class II portions of the TWRS-P Facility electrical system are designed to the following implementing codes and standards:

1) NFPA 70, *National Electrical Code*

2) IEEE-338, *Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems*

3) IEEE-603, *Standard Criteria for Safety Systems for Nuclear Power Generating Stations*, IEEE 603-1980, Institute of Electrical and Electronics Engineers, Inc., New York, New York.

4) IEEE-344, *Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*

5) IEEE-384, *Standard Criteria for Independence of Class 1E Equipment and Circuits*

6) IEEE-387, *Standard Criteria for Diesel Generator Units Applied as Standby Power Generating Stations*

4.3.10 Instrumentation and Control Systems{tc \l3 "4.3.10 Instrumentation and Control Systems}

This section describes the integrated control system use for monitoring and control of the TWRS-P Facility and the instrumentation and control provided tank 241-AP-106. Separate systems are provided for audio intercommunication, public address and building evacuation, and closed circuit television.

4.3.10.1 Integrated Control System. The Integrated Control System (ICS) provides monitoring and control of the chemical process equipment and mechanical handling systems. The ICS includes operator interfaces at 10 separate workstations within the Central Control Room (CCR), 5 fixed local workstations within the process building, and at portable workstations that can be connected to approximately 100 outlets within the TWRS-P Facility. During normal operation, the facility processes are automatically controlled by the workstations located in the CCR and the fixed local workstations within the process building.

CCR Workstations. The CCR workstations are provided for monitoring and control of the chemical process and associated process services, ventilation, environmental monitoring, and building evacuation. Within the CCR, the 10 workstations have the ability to fully control all the systems within their area. Additionally, some degree of redundancy is applied to the workstations such that if a workstation becomes inoperable, control functionality is available from another workstation. The CCR workstations are provided for monitoring and control of the following:

1) Pretreatment including: LAW receipt, evaporation, and removal of entrained solids, Sr/TRU, cesium, and technetium (three workstations)

2) LAW vitrification (one workstation)

3) HLW vitrification or cesium line in the LAW-Only option (one workstation)

4) Vitrification support services, glass formers, quencher, and the offgas systems (two work-stations)

5) Out cell services, e.g., inactive feeds, vacuum and air systems, fire protection, fuel oil, water and steam systems, and sewage treatment (one workstation)

6) Ventilation systems, waste management, electrical power distribution, lighting, fire detection, and closed circuit television (one workstation)

7) Storage, export, and maintenance facilities (one workstation).

Fixed Local Control Workstations. The fixed local workstations are similar to the CCR workstations, but are industrially hardened. They are used for mechanical handling operations that are dependant on continuous operator interactions, and as such, are located in the operating areas adjacent to the equipment under control. The fixed local control workstations are structured such that each of the systems assigned to the individual control workstations operates independently of the other control workstations and their associated systems. Fixed local control work stations are provided for the following areas:

1) LAW vitrification area (e.g., for container import and export; operation of the pour cell bogie system; glass pouring; container cooling; equipment decontamination; container decontamination, swabbing and monitoring; and melter maintenance)

2) HLW vitrification area (e.g., for container import and transport; container filling and cooling; equipment decontamination; lid positioning and welding; container decontamination, swabbing, and monitoring; and melter maintenance)

3) Cesium line (e.g., cesium product canister handling, charging, and transport)

4) Storage export and maintenance (e.g., melter construction; C3 maintenance[1]; in cell crane and bogie maintenance; flask handling; and HLW, LAW, and solid waste handling).

Portable Control Workstations. For operation of in-cell remote handling equipment, portable workstations can be located next to the appropriate window at the cave face. The portable control workstations are used where nonroutine operations are dependent on continuous operation interaction; such as, inching of individual drives during maintenance. The portable control workstations are compact, industrially hardened workstations. A socket is provided at each caveface windows to enable a portable control workstation to be connected to the control system. The portable control workstations access the facility control system via these sockets. The sockets are Acoded@ such that the point of control can be recognized by the system. All normal and maintenance control actions are available from the portable control workstation for the appropriate area.

Features of the ICS. The ICS includes the following features:

1) Autonomous facility controllers are allocated to a bounded area of facility or process such that loss of one area will not hinder the operation of the remaining areas.

2) A mapping, tracking and product quality system with associated database is used for long-term storage and retrieval

3) Electronic document management system stores of facility manuals and live product documentation. This system enables an operator to retrieve previously stored facility documentation (e.g., operation and maintenance manuals) and display them on operator workstation. Facility engineering drawings are available on the CCR workstations and on the fixed control workstations. Drawings can be obtained form a plotter located within the CCR.

4) Detailed facility diagnostic facilities, including online diagnostic routines detects faults down to the module level.

5) There are data links to external facilities.

6) Online configuration/software programming and debugging tools are available.

7) A Management Information System (MIS) is provided to assist the facility operator in the optimization of facility performance. The MIS is a standalone system, although it is connected to the facility communication network to allow authorized personnel access to the stored data. The MIS collects data regarding the feed materials to the facility, together with data regarding how they are processed (both current and historical), and facility

(1) C3 areas are areas normally unoccupied but do allow operator access for such activities as maintenance.

performance. The MIS provides the operations staff with information to assist in the facility operation.

Portions of the integrated control system are designated as Design Class II. The design, construction, and operation of the Design Class II features of the system are in accordance with the SRD Safety Criteria identified in Table 4-22.

Table 4-22. SRD Safety Criteria Applicable to Design Class II Instrumentation and Control Systems

SRD Safety Criterion	Subject[1]
4.1-4	SSCs shall be designed to withstand the effects of natural phenomena without loss of safety function.
4.4-3	Design Class II systems and components shall be designed and constructed to permit testing, inspection, and maintenance throughout their operating life to verify continued acceptability for service with an adequate safety margin.
4.3-4	Design Class II instrumentation and controls shall be provided to monitor variables and systems, control systems, and components over their anticipated ranges for normal operation, anticipated operational occurrences, and accidents as required to assure the radiological and chemical exposures standards of SRD Safety Criterion 2.0-2 are not exceeded.
4.3-6	The possibility of human error in facility operations shall be taken into account in the design by facilitating correct decisions by operators, inhibiting wrong decisions, and providing means for detecting and correcting errors.

Note: [1] Refer to the *Safety Requirements Document* (BNFL 1997g) for the complete wording of the listed Safety Criteria.

The Design Class II portions of the TWRS-P Facility integrated control system are designed to the following implementing codes and standards:

1) IEEE-344, *Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*

2) IEEE-603, *Standard Criteria for Safety Systems for Nuclear Power Generating Stations*
3) IEEE 1023-1988. *Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations*.

4.3.10.2 Instrumentation and Control for Tank 241-AP-106. The instrumentation and control for tank 241-AP-106 are discussed in Section 4.3.7.4, ΑModifications for tank 241-AP-106.@

4.4 PROCESS SAFETY INFORMATION{tc \l2 "4.4 PROCESS SAFETY INFORMATION}

In accordance with the requirements of 40 CFR 68, a single Risk Management Plan (RMP) is written to the format and content requirements of 40 CFR 68, Subpart G, ΑRisk Management Plan.@ The RMP is reviewed and updated in accordance with the requirements of 10 CFR 68.190, AUpdates.@ A qualified individual is assigned the overall responsibility for the development, implementation, and integration of the elements of the risk management program. When the responsibility for implementing individual requirements of the program is assigned to other persons, the names or positions are documented and the lines of authority defined through an organization chart or similar document.

A compilation of written process safety information is maintained to 1) enable the TWRS-P Facility employees involved in operating processes to identify and understand the hazards posed by those processes involving hazardous chemicals, 2) facilitate the maintenance of the process hazards analysis, and 3) facilitate development of operator procedures and training. The following information is maintained:

1) Toxicity information
2) Permissible exposure standards
3) Physical data
4) Reactivity data
5) Corrosivity data
6) Thermal and chemical stability data
7) An assessment of the effects of inadvertently mixing different materials.

A list of the process chemicals used in the TWRS-P Facility and their hazardous characteristics is provided in Section 4.1.2, AProcess Chemicals.@ of the HAR (BNFL 1997d) Most of the information regarding the chemicals is available in Material Safety Data Sheets, which are accessible to all employees. Information on interactions is prepared in the form of an interaction matrix developed for the Process Hazards Analysis (PHA). The interaction matrix for the TWRS-P Facility is provided in Section 4.2, AChemical Interactions,@ of the HAR.

Information pertaining to the technology of the process is also maintained. This information includes the following:

1) Block flow diagrams and simplified process flow diagrams

2) Process chemistry

3) Maximum intended inventories

4) Safe upper and lower limits for such variables as temperatures, pressures, flows, and compositions

5) Evaluation of the consequences of deviations, including effects on the health and safety of employees.

Process technology information is developed as the design evolves. Changes in the technology are reviewed by hazard evaluation and controlled by the configuration management process.

A third group of information pertaining to technology and equipment in the process is maintained. This information includes the following:

1) Materials of construction
2) Process and instrumentation diagrams
3) Electrical classification for fire protection
4) Press relief system and design basis
5) Ventilation system design
6) The design codes and standards employed
7) Material and energy balances
8) Safety systems (e.g., interlocks and detection or suppression [control] systems).

This information is developed and assembled as the design evolves.

Applicable process safety information is maintained and kept up to date as required by the TWRS-P Facility configuration management program discussed in Section 3.1, AConfiguration Management.@ Additional information on the chemical safety program and compliance to 29 CFR 1910.119, AProcess Safety Information of Highly Hazardous Materials, A is provided in Chapter 7.0, AChemical Safety.@

4.5 TRAINING AND QUALIFICATION OF INTEGRATED SAFETY ANALYSIS TEAM{tc \l2 "4.5 TRAINING AND QUALIFICATION OF INTEGRATED SAFETY ANALYSIS TEAM}

The ISA process includes the identification of hazards and hazardous situations by the PHA process and the performance of accident consequence analysis for selected hazardous situations.

By staffing the teams with experienced and knowledgeable individuals from varying disciplines, the qualification of the PHA hazard evaluation teams is established. These individuals collectively bring experience and knowledge pertinent to the facility and processes under study. At least one member knowledgeable in the specific PHA methodology being used. A typical PHA team includes knowledgeable representatives from

1) Processing engineering
2) Mechanical engineering
3) Instrumentation and controls engineering
4) Operations and maintenance
5) Technology and development
6) Radiation and shielding design and analysis.

The HAR documents the membership of each PHA hazard evaluation team, noting each team member=s area of expertise. Biographical summaries are prepared for study team members that support the stated area of expertise.

Before PHA meetings are conducted, a training session is held for those who have not previously participated in a hazard evaluation study. This training ensures that team members understand the PHA procedure and that full and informed participation in the exercise is able to take place. The training consists of information covering the reasons for conducting a hazard identification and evaluation, the use of the checklist, how the meetings will be conducted, and how the results will be documented and follow up actions. The method of team selection, including qualifications and optimization of the team size, are explained. Details of preparation for the meeting (i.e., review of PHA data from relevant facilities), and the method for review and closure of the study results are discussed. Following these training sessions, a designer or process engineer, with the knowledge of the facility and expertise in the area of the review begins the meeting by giving a description of the activity or the process operation.

For individuals who perform safety analysis other than serving on a PHA hazard evaluation team, such as accident selection and analyzing accident consequences, the training and qualification include comparing the documented job assignment to the experience of the individual. For example, personnel who analyze accidents should be knowledgeable in performing these types of analyses for similar facilities. Where a lack of experience is identified, the expertise is supplemented by the participation of other individuals or classroom instruction is undertaken, required reading is completed, or on-the-job training is provided to address this lack of experience.

All individuals performing ISA activities are provided training in the BNFL Inc. Quality Assurance Program (QAP), the QAP for the participating organization, or both. This training also includes training in applicable QAP implementing procedures.

4.6 INTEGRATED SAFETY ANALYSIS METHODS{tc \l2 "4.6 INTEGRATED SAFETY ANALYSIS METHODS}

This section presents the methods for hazards identification and evaluation and accident consequence analysis applied to the TWRS-P Facility.

4.6.1 Hazard Identification and Evaluation{tc \l3 "4.6.1 Hazard Identification and Evaluation}

This section discusses the PHA used for the identification and evaluation of hazards and hazardous situations for the TWRS-P Facility. The results of the PHA are provided in the HAR (BNFL 1997d).

4.6.1.1 Process Hazard Analysis Methodology. The selected hazard evaluation methodology for the TWRS-P Facility for Part A is similar to the combination of What-If Analysis and Checklist Analysis (WI/CL) as defined in the American Institute of Chemical Engineers (AIChE) Guidelines (AIChE 1992). In Part B a hazard and operability (HAZOP) approach will be used. The WI/CL methodology uses a team approach for the identification of hazards and hazardous situations. The evaluations resulting from this approach make use of the team=s experience and the creativity of a brainstorming process to raise What-If questions and use a checklist to supplement the team's thought process.

A WI/CL analysis used for the TWRS-P Facility PHA consists of the following steps: (1) drawing on previous operations experience in preparing for the review, (2) developing a list of What-If questions and concerns, (3) using a checklist to supplement the What-If approach, (4) evaluating each question and concern, and (5) documenting the results. In the hazard evaluation of the TWRS-P Facility, steps 2 and 3 are reversed. The AIChE Guidelines (AIChE 1992, p. 123) recognizes the reversal of Steps 2 and 3 as an acceptable variation.

A qualified team is assembled by the hazard evaluation study leader who has determined the physical and analytical scope of the proposed study. If the activity is large, the team leader divides it into functions, physical areas, or tasks to facilitate the review of the process. The TWRS-P Facility is reviewed in modules. The scope, preparation, and the process flow diagram reviewed in each of the modules are described in HAR Chapter 5.0 AHazard Evaluation by Process Step@ (BNFL 1997d). The process module and the team composition are determined by the team leader and the process engineers in a hazard evaluation study pre-meeting before the hazard evaluation study team meeting. Engineering flow diagrams, waste compositions, and preliminary facility layouts are made available to the hazard evaluation team at least one week in advance of the first hazard evaluation meeting.

As defined by the AIChE Guidelines (AIChE 1992), in industry practice, an appropriate checklist is developed by the team leader for team use in conjunction with the What-If analysis. The checklist used for hazard evaluation of the TWRS-P Facility process is the checklist in common use to identify and assess the significance of hazardous situations in similar BNFL designs and facilities. The hazard evaluation study team reviewed the BNFL checklist in the hazard evaluation pre-meeting and excluded or added checklist items based on their experience and familiarity with the design and with the hazard evaluation method.

A checklist of guidewords are used in the hazard evaluation meetings to elicit responses from team members and to ensure potential deviations from normal operations are covered. Suggested guidewords are listed at the end of Chapter 6.0 of the AIChE Guidelines (AIChE 1992).

The BNFL checklist covers the categories of deviations found in the example checklists in the AIChE Guidelines (AIChE 1992). Cross-matching of AIChE checklist words with the BNFL checklist finds that extreme weather, and seismic are unlisted in the AIChE Guidelines example tables. Comparison also shows that BNFL=s list is thorough in encompassing the variety of typical deviations from normal operations. In the BNFL checklist, AChemical Reaction@ is addressed by AFire@ and AExplosion/Overpressure.@

In addition, the BNFL example checklists provide a more detailed listing than the AIChE checklist. For example, occupational safety is cross-referenced to the categories of electrical, heat and temperature, mechanical, and vibrational, each with a detailed list of hazards. The listed hazards in these categories are worker hazards in the operating area of the facility, an area of limited design development at this time. The consideration for worker hazards will be brought to a level consistent with the process in Part B. The checklist used for the Part A PHA is as follows:

1) External Dose
2) Internal Dose
3) Shielding
4) Criticality
5) Loss of Containment
6) Ventilation
7) Fire
8) Explosion/Overpressure
9) Maintainability
10) Remote Handling
11) Loss of Services
    a) power
    b) steam
    c) water
    d) air

e) process chemicals
f) other
12) Effluent/Washing
13) Corrosion/Erosion
14) Knock-on
15) Extreme Weather
a) wind
b) temperature
c) rainfall
d) snow
e) lightning
f) flooding
16) Seismic
17) Dropped Load/Impact
18) Occupational Safety
a) machinery
b) noise
c) electricity
d) manual handling
e) inert gases

A hazard evaluation study that limits the focus to the equipment and overlooks the changes in the operation is likely to be found incomplete. In the pre-meeting, with the help of the process engineers, the team leader identifies each process step or activity to be studied in the hazard evaluation meeting. Process activities or operations often consist of distinct steps, with different possible deviations from normal operations at each step. All variations in the operation were studied in the hazard evaluation study. For example, two activities in ion exchange are the adsorption or loading of specific ions in solution by the ion exchange medium followed by elution of the adsorbed ions off the ion exchange medium. Because the hazards are different in each process step, the team leader guides the team through a study of the loading and elution steps. This approach satisfies Section 4.6.b.v of *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility* (draft NUREG-1520 [NRC 1995b]), "...it (the hazard evaluation technique) addresses all modes of operation including startup, operation, shutdown, and maintenance."

4.6.1.2 Conduct of Process Hazard Analysis Meetings. Before the hazard evaluation meeting, a training session is held for those that have not previously participated in a hazard evaluation study as discussed in Section 4.5, ATraining and Qualification of ISA Team.@

A designer or process engineer with knowledge of the facility and expertise in the area of the review begins the meeting by giving a description of the activity or the process operation. The team then considers each checklist item to see whether any potential accident situations or concerns arise. For the TWRS-P Project hazard evaluation study, unless there was an interface concern from the review of another module, the guidewords were used as checklist items by the leader to initiate the cause and effect thought process of team members. What-If questions were formulated during the hazard evaluation meetings.

The subject process step and the checklist item are reviewed by team members who use their combined expertise and experience and team interaction to express concerns. The questions and concerns are recorded by a team member. The team leader leads the team through each item on the checklist. This process is repeated for each area or step of the process or activity. Table 4-23 is an example Study Record Sheet from the hazard evaluation meetings for the TWRS-P Project. The raw data recorded on the study record sheets serve as the basis for the development of the fault schedules included in the HAR (BNFL 1997d).

Table 4-23. Hanford TWRS-P Study Record Sheet, Example

Keyword	Initiating Event	Hazard Scenario	Design Provision	Assump-tions	Notes	Action Re-quired
External Dose	Extended shutdown. Overfilling of DST. Leak of tank to annulus. Tank failure due to rupture.	Additional maintenance activities required. Mis-routing of feed liquors. Loss of liquor to annulus. Vent system pulls up bottom of tank-distortion.	Leak detection of liquor in the annulus. Secon-dary vent system. Cannot empty tank below 6".		TWRS FSAR report listing put forward for discussion (See Mickey Beary action in Facility Area 1 under keyword AFire.@) Any additional concerns have been listed in this record. Primary tank related concerns. The 6" heel will prevent uplifting of tank base by vent pulling a vacuum.	

The team leader takes the listing of questions and concerns, safeguards, and recommendations or action items prepared in the meetings and summarizes them on the fault schedule. The fault schedules for each process step are contained in HAR Chapter 5.0 AHazard Evaluation by Process Step.@ The hazard evaluation techniques identify safety and operability concerns. The fault schedules provided in HAR Chapter 5.0 address safety concerns. Maintenance, operability, and environmental fault schedules are listed in HAR Appendices A through C (BNFL 1997d).

4.6.2 Ranking of Hazards and Accident Identification{tc \l3 "4.6.2 Ranking of Hazards and Accident Identification}

This section discusses the process by which the hazardous situations (event sequences) identified on the fault schedules were ranked in terms of frequency and consequence and how specific events were identified for accident consequence analysis.

4.6.2.1 Ranking of Hazards. The hazard evaluation team reviewing a particular module qualitatively evaluate the frequency of the event and its potential consequences to the worker and public. The team assigns the accident scenarios a frequency category from those listed in Table 4-24 and a consequence category from those listed in Table 4-25. Substantiation of the consequence ranking is a subsequent activity for the safety analysis provided in Section 4.7, AResults of the Integrated Safety Analysis.@ This is where the bounding consequence resulting from the accidents ranked as those with the highest potential consequence are estimated.

Table 4-24. Frequency Categories

Frequency Category (Fault Schedule)	Description	Frequency (F) of Occurrence (per yr.)
4	Normal Events: Events/hazardous situations that may occur regularly in the course of facility operations	F>1
3	Anticipated Events: Events/hazardous condition of moderate frequency that occur once or more during the life of a facility	$1>F>10^{-2}$
2	Unlikely Events: Events/hazardous conditions that are not expected, but may occur during the lifetime of the facility	$10^{-2}>F>10^{-4}$
1	Extremely Unlikely Events: Events/hazardous conditions that are not expected to occur during the lifetime of the facility, but are postulated because their consequences have potential for a significant release	$10^{-4}>F>10^{-6}$

Table 4-25. Definition of Consequences

Effect	CONSEQUENCE			
	Negligible (1)	**Minor (2)**	**Serious (3)**	**Major (4)**
General Definition. The effects given be-low are more detailed definitions and examples of this entry.	**Negligible impact to worker and public**	**Minor impact on the workers, public, or environment**	**Considerable impact on the worker or the environment; only minor public impact**	**Considerable impact on the workers and public impacts or the environment**
Impact on Public				
Dose Rates	#100 mrem / yr.	# 100 mrem / event	5 rem / event	25 rem / event
Hazardous Release (i.e., a release of radioactivity)	Releases within exposure standards	Releases above normal causing investigation and justification to regulatory authorities, but with operations continued.	Releases exceed dose standards causing regulatory authorities to temporarily shut down facility.	Major release causing regulatory authorities to permanently shut down facility.
Impact on Workers				
Criticality (Note the safety criterion is assumed to be no criticality allowed)	Full margins retained	Some erosion of margins requiring corrective action.	Reduction in margins requiring increased monitoring and changes in facility operation during the event	Margins to criticality lost. Facility is shut down and cleaned up.
Radiation Dose Rates	Exposure rates compliant with zoning scheme	Exposure rates increased above normal	Exposure rates >20 mrem/h in large parts of operating area with unrestricted worker access	Exposure rates >20 mrem/h in unclassified areas
Contamination Levels	Contamination levels compliant with zoning scheme	Contamination levels increased above normal	Contamination levels > 100 DAC in large parts of operating area with unrestricted worker access	Contamination levels > 100 DAC in unclassified areas
Worker Health (applicable to all causes - radiation, contamina-tion, toxic chemicals, accidents at facility, etc.)	No effects	First aid may be required, but continued working is possible	Urgent medical attention and time off work may be required	Permanent disability or death
		Facility Integrity		
Facility Damage	No effects	Unscheduled maintenance may be required: there may be some reduction in	Facility is shut down for major repair.	Facility is damaged beyond economic repair.

Table 4-25. Definition of Consequences

Effect	CONSEQUENCE			
	Negligible (1)	**Minor (2)**	**Serious (3)**	**Major (4)**
General Definition. The effects given be-low are more detailed definitions and examples of this entry.	**Negligible impact to worker and public**	**Minor impact on the workers, public, or environment**	**Considerable impact on the worker or the environment; only minor public impact**	**Considerable impact on the workers and public impacts or the environment**
		facility production.		

Note: DAC = derived air concentration

In discussions about potential cause and effect of particular accident scenarios in the follow-up session, the hazard evaluation team qualitatively assigns the accident scenario to a frequency category based on the team's judgement and experience. The information necessary to support the team experience and judgement in this matter will be demonstrated in Part B during which such design documents as process and instrument diagrams, failure modes and effects analysis, fault tree analysis, and event tree analysis will be available.

The hazard evaluation team assigns a consequence value based on a qualitative or semi-quantitative scale to each accident. The scale is based on a simplified description of the consequence of potential accidents. Examples of such scales for both frequency and consequence are found in the AIChE Guidelines (AIChE 1992).

The hazard evaluation team consensus on consequence to the worker and public is based on the inventory of hazardous material and the energy released during the accident. The energy released affects the dispersion of radioactive and toxic material and may result in failure of barriers. Explosions, fires, and failures under high pressure, depending on the inventory, are events that are likely to be the most serious in the comprehensive list of accidents generated by the hazard evaluation study.

4.6.2.2 Accident Selection. From the hazardous situations identified by the PHA teams, the accident selection process identified those accidents that present the potential for serious risk to the worker or public. From the candidate accident scenarios, a set of unique and bounding scenarios were chosen for quantification of the unmitigated consequences.

The selection of candidate accident scenarios for detailed analysis were made primarily from the hazardous situations having the highest potential consequences if unmitigated as identified by the PHA teams. The WI/CL method used to identify hazards in the HAR provided frequency information in very broad categories. Candidate accident selection based primarily on assignment of relative risk ranking was not used because it would have eliminated potentially high-consequence scenarios that should be considered for early design decisions.

The fault schedules were first sorted for all events assigned by the PHA teams as consequence Category 3 or 4 for either the worker or the public (defined in Table 4-25). For completeness, the lists were augmented by events assigned consequence Category 2 for quantification because they presented unique hazards comparable in severity to, but not included in the Category 3 and 4 sets. Events were also added for which the frequency of the initiator was estimated to be a high (i.e., perceived high risk), a common-cause initiator with other events could make the releases additive, or ones for which credit had been taken for mitigating features.

The remaining consequence Category 2 events and those assigned consequence Category 1 were not considered candidates for quantification of the consequences. However, in Part B, as design progresses, they will be examined in the context of considering necessary design features for facility worker protection and defense-in-depth.

The list of candidate accidents were then sorted into groups, based on similar initiators (e.g., liquid spills, and fires) One or more events from each group were selected for further development to provide scenarios for consequence analysis that represent the phenomenological progression and bound the consequences of the other scenarios in the group.

4.6.3 Methodology for Accident Consequence Analysis{tc \l3 "4.6.3 Methodology for Accident Consequence Analysis}

For the TWRS-P Facility, inhalation is the primary pathway for radiological exposure for the public and co-located workers. Potential exposure from ingestion and direct radiation does not need to be considered. Previous analyses performed for the Hanford Site for similar releases indicate that because of the distance to the nearest point of public access, the release is sufficiently dilute that exposure from direct radiation does not contribute significantly to the overall exposure. The effective emergency response preventing consumption of agricultural products that may lie in the path of the release is the reason for not considering potential exposure from ingestion. Experience has also shown the exposure pathway from submersion is also not a significant contributor to the total exposure.

$$CEDE = \frac{X}{Q} \; x \; R \; x \sum(M_i \; x \; C_i)$$

The radiological exposure to a receptor is calculated using the following equation:
where

CEDE	=	Fifty-year committed effective dose equivalent to the receptor (Sv)
X/Q	=	Time-integrated atmospheric dispersion coefficient (s/m^3)
R	=	Breathing rate (m^3/s).
M_i	=	Quantity of each radionuclide in the respirable material released (Bq), from Equation 2 below
C_i	=	Dose conversion factor for each radionuclide (Sv/Bq)
i	=	index to identify each radionuclide of interest

$$M_i = MAR_i \; x \; ARF \; x \; RF$$

and
where

MAR_i	=	quantity of each radionuclide released (Bq)
ARF	=	Airborne release fraction
RF	=	Respirable fraction.

The quantity of each radionuclide in the respirable material released (M_i) is determined by the specific accident scenario. It is estimated by first determining the total quantity released by the accident initiator. The fraction of the total release predicted to become airborne is the airborne release fraction (ARF). The predicted fraction of the ARF that is considered to be of respirable size is the respirable fraction (RF). ARF and RF values are generally chosen from the data in the *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities,* DOE-HDBK-3010-94 (DOE 1994a). Other sources for ARF and RF are used when the handbook does not provide applicable data.

Multiplying the radiological release source terms by the airborne dispersion coefficient ÷/Q and a breathing rate gives the quantity of the released material the hypothetical receptor may inhale.

Atmospheric dispersion coefficients for the TWRS-P Facility are calculated as discussed in Section 4.1.3.4, AShort-Term Diffusion Estimates.@ When the duration of the release is less than one hour, no credit is taken for building wake effects or plume meander in the airborne dispersion coefficient used. For a release sustained for greater than one hour, the airborne dispersion coefficient takes credit for these effects.

The breathing rate (R) depends on activity factors and exposure duration. The breathing rate used for releases assumed to be of less than 8 hours duration is 3.47×10^{-4} m^3/s. For releases assumed to be between 8 and 24 hours duration, the breathing rate is 1.75×10^{-4} m^3/s. These are the values recommended by the International Commission on Radiation Protection *Reference Man: Anatomical, Physiological, and Metabolic Characteristics* (ICRP 1975) and adopted by NRC Regulatory Guide 1.3, *Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors* (NRC 1974).

To calculate the exposure to the receptor per unit material inhaled, the quantity of each radionuclide is first multiplied by the published dose conversion factor for inhalation of that radionuclide. The committed effective dose equivalent (CEDE) is the sum of the doses from all radionuclides present in the inhaled material. EPA-520, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (EPA 1988) gives dose conversion factors for various radionuclides. The inhalation dose conversion factors used for the radionuclides of importance to the TWRS-P Facility analysis are reproduced in Table 4-26.

The public receptor is considered to be exposed for a maximum of 24 hours and the co-located worker for 8 hours. Longer periods are considered for events for which the detection of the release may be delayed or there may be some difficulty in achieving protective action recommendations.

For the toxic releases from accidents, the consequence analysis uses the data recommended by the Environmental Protection Agency (EPA) in *RMP Offsite Consequence Analysis* (EPA 1996). Tables are provided in this reference for determining the minimum distance from the release where the airborne concentrations of the released material are lower than the exposure limit for that material.

4.6.4 Identification of Accident Prevention and Mitigation Features{tc \l3 "4.6.4 Identification of Accident Prevention and Mitigation Features}

This section discusses the process by which engineered and administrative controls are identified for the protection of public and worker safety.

Table 4-26. Inhalation Dose Conversion Factors, C_i, for Radionuclides[a]

Radionuclide	Inhalation Dose Conversion Factor (Sv/Bq)
Cs-137	8.63×10^{-9}
Cs-134	1.25×10^{-8}
Sr-90	6.47×10^{-8}
Tc-99	2.25×10^{-9}
Co-60	8.94×10^{-9}
Eu-154	7.73×10^{-8}
Eu-155	1.12×10^{-8}
Pu-239	1.16×10^{-4}
Pu-240	1.16×10^{-4}
Pu-241	2.23×10^{-6}
Am-241	1.20×10^{-4}
Cm-244	6.7×10^{-5}

Note:
a. From EPA, 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, EPA-5201/1/88/020, U.S. Environmental Protection Agency, Washington, D. C.

4.6.4.1 Protection of Public Safety. For those accidents that involve a radionuclide release, the calculated exposures are compared to the radiological exposure standards of Table 4-27 to determine the need for accident prevention or mitigation features for public safety. For chemical release, the projected exposure is compared to the standards in Emergency Response Planning Guide-2 (ERPG-2 [AIHA 1988]).

Accidents are first analyzed unmitigated, i.e., without credit for engineered or administrative controls. If the radiological or chemical release exposure standards are not satisfied, engineered or administrative controls are added (or credit is taken for existing controls) until the standards are satisfied. Preference is given to engineered features over administrative controls. Preference is also given to passive over active engineered features. Engineered features credited for satisfying the public radiological exposure standards of Table 4-27 and a chemical release exposure standards of ERPG-2 (AIHA 1988) are classified as Design Class I. Administrative controls credited for satisfying the radiological or chemical exposure standards would become the basis for technical safety requirements if needed. No need has yet been identified for administrative controls as DC 1.

Table 4-27. Radiological Exposure Standards Above Normal Background

Description	Estimated Frequency of Occurrence $f\ (yr^{-1})$	General Guidelines	Worker	Co-located Worker	Public
Normal Events: Events that occur regularly in the course of facility operation (e.g., normal facility operations).	Any Normal Event	Normal modes of operating facility systems should provide adequate protection of health and safety.	C #5 rem/yr C #50 rem/yr any organ, skin, or extremity C #15 rem/yr lens of eye C #1.0 rem/yr C ALARA design objective per 10 CFR 835.1002(b)[1]	C #5 rem/yr C #1.0 rem/yr C ALARA design objective per 10 CFR 835.1002(b)[1]	C #10 mrem/yr (airborne pathway) C #100 mrem/yr (all sources) C #100 mrem/yr (public in the controlled area) C #25 mrem/yr (radioactive waste)
Anticipated Events: Events of moderate frequency that may occur once or more during the life of a facility (e.g., minor incidents and upsets).	10^{-2}<f#10^{-1}	The facility should be capable of returning to operation without extensive corrective action or repair.	C #5 rem/event[2,3] 1.0 rem/event design threshold[4]	C #5 rem/event[2,3] 1.0 rem/event design threshold[4]	C #100 mrem/event[3]
Unlikely Events: Events that are not expected, but may occur during the lifetime of a facility (e.g., more severe incidents).	10^{-4}<f#10^{-2}	The facility should be capable of returning to operation following potentially extensive corrective action or repair, as necessary.	C #25 rem/event[2,3]	C #25 rem/event[2,3]	C #5 rem/event[3]
Extremely Unlikely Events: Events that are not expected to occur during the life of the facility but are postulated because their consequences would include the potential for the release of significant amounts of radioactive material.	10^{-6}<f#10^{-4}	Facility damage may preclude returning to operation.	C #25 rem/event[2,3]	C #25 rem/event[2,3]	C #25 rem/event C [#5 rem/event target][3] C #300 rem/event to thyroid
Location of Receptor			Within the BNFL TWRS-P Controlled Area Boundary, including AP 106	The most limiting location at or beyond the BNFL TWRS-P Area Boundary	The most limiting location along the near river bank/ Hwy240 /southern boundary

Table 4-27. Radiological Exposure Standards Above Normal Background

Description	Estimated Frequency of Occurrence f (yr^{-1})	General Guidelines	Worker	Co-located Worker	Public

Notes:

1) In addition to meeting the listed design objective of 10 CFR 835.1002(b), the inhalation of radioactive material by workers and co-located workers under normal conditions is kept ALARA through the control of airborne radioactivity as described in 10 CFR 835.1002(c).
2) In addition to meeting the listed worker and co-located worker exposure standards for accidents, the Worker Accident Risk Goal Is satisfied through the calculation of the risk from accidents with accident prevention and mitigation features added as necessary to meet the goal.
3) In addition to meeting the listed exposure standards for accidents, BNFL=s approach to accident mitigation is to evaluate accident consequences to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis and to provide for sufficient design margin and operational flexibility.
4) When a calculated accident exposure exceeds this threshold, then appropriate actions are taken. These include carrying out a less bounding (i.e., more relaistic) evaluation to show that the accident copnsequences will be below the threshold or evaluationg additional safeguards for cost-effectiveness and/or feasibility. This threshold is not a limit; it does not require the implementation of additional preventative or mitigative features if they are not both cost-effective and feasible.

If credit is taken for operator action to satisfy the public radiological exposure standards of Table 4-27, adequate radiation protection is provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body gamma and 30 rem beta skin for the duration of the accident. If credit is taken for operator action to satisfy the public chemical exposure to (EPRG-2) limits (AIHA 1988), provisions are made such that the operator exposure does not exceed the EPRG-2 limits.

The location of the public (i.e., offsite receptor) for the purpose of establishing compliance with Table 4-27 and the chemical release standard, is established at the most limiting exposure location along the near bank of the Columbia River, Highway 240, and a southern boundary as shown in Figure 4-2.

A conservative approach is applied to accident consequence analysis in terms of input assumptions, boundary conditions, modeling techniques, and compliance with public radiological and chemical release standards. This conservatism is applied to account for uncertainties in the analysis and to provided for sufficient design margin and operational flexibility. As the process and facility design mature in Part B, the analysis is refined to eliminate unnecessary conservatism that may have been applied solely to cover uncertainties in design. This strategy is consistent with a risk-based approach that allows the use of uncertainty analysis to better identify the impact of the assumptions and state of knowledge on results from the safety analysis.

4.6.4.2 Protection of Worker Safety. Under accident conditions radiological exposure standards applied to the facility worker and co-located worker are provided in Table 4-27. For chemical release, the projected exposure is compared to the standards in ERPG-2 (AIHA 1988). The location of the workers is shown in Figure 4-30. A 5-rem/event standard is applied to the workers for anticipated events, and a 25-rem/event exposure standard is applied to workers for unlikely and extremely unlikely events. The 25-rem/event standard corresponds to the once-in-a-lifetime accident or emergency exposure for radiation workers which, by recommendation of the National Council on Radiation Protection and Measures (NCRP 1963), may be disregarded in the determination of their radiation exposure status. In addition, an exposure of 25 rem/event corresponds to a conditional probability of fatality of about 2×10^{-2}. For unlikely events (defined in Table 4-27 as having a maximum occurrence frequency of 10^{-2}/yr), this equates to a maximum increase in worker lifetime risk of premature death of about 2×10^{-4} /yr, which is less than the average of the accidental death risk for workers in some of the safest industries, such as retail and wholesale trade, manufacturing, and service according to the *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* (EPA 1991).

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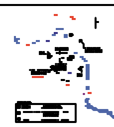
TWRS-P PROJECT
INITIAL SAFETY ANALYSIS REPORT
BNFL-5193-ISAR-01, REV. 0



January 12, 1998

Compliance with the 25 rem/event worker standard is established using qualitative methods of the PHA supported, where necessary, by numerical analyses that may include the development of event trees and fault trees or the performance of consequence analyses. From this process, preventative and mitigative engineered and administrative controls to be added to the design are identified. The PHA identifies hazards and operability problems based on the design detail available and BNFL experience with similar facilities. Further hazard evaluation takes place in parallel with design development to ensure that safety is built into the design process. Having generated the list of hazards, this list is subject to a further systematic team-based review where a binning process takes place. The binning process, discussed in Section 4.6.2, ARanking of Hazards and Accident Identification,@ is essentially the risk-based categorization of hazards and hazardous situations according to a frequency/consequence matrix.

The 25 rem/event worker standard for unlikely or extremely unlikely events applies to events with frequencies less than 10^{-2}/yr. For those frequencies, the PHA assigns serious and major hazardous situations as either undesirable, acceptable with controls, or acceptable. For a hazardous situation to be acceptable, the situation must have consequences less than 25 rem. Where there is uncertainty concerning the appropriate category to be assigned a particular hazard, the hazard is binned to the higher category to ensure that the accident analysis remains conservative.

The worker accident risk goal is stated in *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors,* DOE/RL-96-0006 as, AThe risk, to workers in the vicinity of the Contractor=s facility, of fatality from radiological exposure that might result from an accident should not be a significant contribution to the overall occupational risk of fatality to workers@ (DOE-RL 1996c, Section 3.1.3). Compliance with this goal is established in Part B by calculating the risk of facility operation to the workers at the TWRS-P Facility. This is a best-estimate analysis based on realistic input and modeling assumptions. In performing this analysis, all SSCs capable of preventing or mitigating the event are considered. The evaluation of the availability and reliability of the SSCs include factors such as failures to start and failures to operate, as well as unavailability resulting from maintenance activities. Accident prevention and mitigation controls are added to the design as necessary to satisfy the worker accident risk goal.

For the worker, accidents are first analyzed unmitigated, i.e., without credit for engineered or administrative controls. If the worker radiological or chemical release exposure standards are not satisfied, engineered or administrative controls are added (or credit is taken for existing controls) until the standards are satisfied. Engineered features credited for satisfying the worker radiological exposure standards of Table 4-27 and for protecting the worker against the chemical release exposure standards of ERPG-2 (AIHA 1988) are classified as Design Class II. Administrative controls credited for satisfying the worker radiological or chemical exposure standards may become the basis for licensee controlled requirements.

Additional details on the radiological exposure standards applied to the public and facility workers are provided in *TWRS-P Privatization Project: Radiological and Nuclear Dose Standards for Facility and Co-Located Workers* (BNFL 1997f). This reference also provides information on the basis for the assumed location of the receptors.

4.6.5 Fire Hazards Analysis{tc \l3 "4.6.5 Fire Hazards Analysis}

A FHA is performed during Part B to demonstrate that the TWRS-P Facility, including all buildings, can be placed in a safe state for all credible fire and explosion conditions. The FHA addresses all modes of operation of the TWRS-P Facility, including normal operation, upset conditions, maintenance shutdown, and loss of normal electrical power.

For the purpose of performing the FHA, the process building is subdivided into four major areas: pretreatment area, LAW area, HLW area (HLW/LAW option) and the support area. In addition, all other buildings, structures and installations throughout the facility are considered in the FHA to identify any fire/explosion exposure hazards, and to address their potential safety impact on the process building and other buildings containing radioactive and hazardous materials (see Section 4.2.1, ABuilding Descriptions@).

The facility is further subdivided into separate fire areas for the purposes of limiting the spread of fire, protecting personnel, and limiting the consequential damage to the facility. Fire areas are separated from each other by fire-resistance rated barriers commensurate with the expected fire severity. Each of the above areas of the process building is analyzed, area-by-area for all fire areas within the building.

In the FHA, in situ and transient radioactive, hazardous, and combustible materials are quantified along with their heat/energy content. Processes and their potential for fire and/or explosion, and any other hazardous operations within the fire area are described and analyzed. Potential sources of ignition that are present in the fire area/zone are taken into account.

Based on the inventory of combustibles and fire area conditions identified above, the analysis postulates a worst-case fire scenario within the fire area. The analysis also establishes the expected severity of the fire, and the consequences and effects of such a fire event.

As a result, the needs for the addition of features and capabilities to prevent fires from starting, and to mitigate the consequences of the fires should they occur, are evaluated. Where provided, the fire detection and alarm system and the fixed suppression systems, are taken into account. Confinement of the fires by fire-resistance rated barriers, and smoke management by the HVAC system to mitigate the consequences of the fires, and for post-fire recovery, are all taken into account.

The FHA establishes the adequacy of the fire protection measures along with the installed mitigating capabilities, and confirms that the facility fire safety objectives are met. Additional fire protection measures, as determined by the results of the FHA, are incorporated in the facility design and installations.

Proposed Licensee Controlled Requirements (LCRs) relative to the fire protection program will be provided in Preliminary Safety Analysis Report (PSAR) Section 4.8, AControls for Prevention and Mitigation of Accidents.@ The final LCRs will be included in Section 4.8 of the Final Safety Analysis Report (FSAR). Section 4.8 of this ISAR describes the format and content of LCRs, including the establishment of limiting conditions for operation (LCOs) and the actions to be taken when an LCO is not satisfied.
In addition to the performance of the FHA, a code compliance analysis will be performed to document and justify deviations from nationally accepted fire safety practice. These justifications

will address the design options available for obtaining compliance with the practices and why it is not reasonable or practicable to implement these design options to achieve compliance.

4.7 RESULTS OF THE INTEGRATED SAFETY ANALYSIS{tc \l2 "4.7 RESULTS OF THE INTEGRATED SAFETY ANALYSIS}

This section describes the selection of representative and bounding accident scenarios from the PHA and presents the consequence analysis of those scenarios. At the early conceptual design phase, consequence analysis gives a preliminary measure of the severity of the potential facility hazards= consequences and highlights the need for engineered features to mitigate or prevent the most severe consequences. Therefore, scenarios are selected for analysis without regard for the likelihood of a particular sequence of events leading to a release. The consequence estimate ignores active engineered features in the preliminary design that play a mitigative or preventive role.

Section 4.7.1 presents the screening of the hazards and selection of accident scenarios for consequence analysis. Section 4.7.2 contains the accident analysis and comparison of accident consequences to the radiological exposure standards for the public and co-located workers given in Table 4-27. Because the design is in the early conceptual stage, the potential consequences to facility workers are assessed only qualitatively. Accident consequences to the facility worker will be analyzed in detail at further design stages. Section 4.7.3 presents the requirements for engineered features to prevent or mitigate potential accident consequences.

The selection of the accidents for consequence analysis is based on the experience and knowledge of the hazards and accident analyses teams, the information available from other radiological and chemical processing facilities, and the results of the hazards identification process. The selection is not intended to represent all potential accidents. However, there is a reasonable expectation that no other credible scenarios would be more challenging to the public or the co-located worker that those evaluated as described in this section. As the design develops, the accident selection process is reevaluated to verify the expectation in light of the new information.

4.7.1 Accident Selection{tc \l3 "4.7.1 Accident Selection}

This section describes the selection of PHA events judged to have potentially high consequences if unmitigated by engineered features or administrative controls (BNFL 1997a). Grouping the events by similar mechanisms for dispersion of hazardous materials, and comparing the hazardous inventory available for release, provide a basis for selecting bounding scenarios for further analysis.

4.7.1.1 Sorting of High Consequence Events{tc \l4 "4.7.1.1 Sorting of High Consequence Events}. The hazard evaluation teams assigned consequence categories to each of the events identified in the PHA and recorded in the fault schedules. Consequences to the worker and to the public were considered separately, and a consequence category was assigned for each.

The potential events for the cold chemical storage area were not covered by the hazard analysis. A separate safety review examined hazardous situations in that area.

To begin the selection of candidate accidents for analysis, the fault schedule database was sorted to bring forth all the events judged to have the potential for serious (category 3) or major (category 4) consequences. The basis for the consequence category assignments are presented in Table 4-25. To ensure completeness, events assigned minor consequence (category 2) were examined to identify those that should be considered for quantification because: 1) they present unique hazards of comparable severity to, but not included in the category 3 and 4 set; 2) the frequency of the initiator is estimated to be high; or 3) a common cause initiator with other events could make the releases additive.

Only those events with potentially high consequences to the public or the co-located worker were considered for further scenario development and analysis. Events judged to have serious or major consequences to the facility worker, but minor or negligible consequences to the co-located worker or the public, were not examined in this accident analysis. Instead, measures to protect the facility workers during events that are not regulated by normal occupational safety requirements are identified by the hazard analysis. Table 4-28 identifies those SSC=s that ensure worker protection is provided.

The events judged to have the potential for significant consequences were then arranged into groups on the basis of the similarity of the phenomena providing the driving force for dispersion of hazardous materials or energy. This arrangement simplifies comparing the potential consequences of the events within a group. Events with the potential for radiological release are treated separately from those involving the release of non-radioactive material.

The groups selected for comparison purposes are:

1) Liquid loss of confinement events. These are primarily spills of radionuclide containing liquids that involve airborne entrainment through splashing and evaporation from pools.

2) Loss of confinement of gases and gas-borne aerosols. These events involve radioactive releases resulting from small pressure differences, or liquid or solid materials rendered airborne by physical mechanisms like boiling or impact.

3) Fires. These are fires involving solid or liquid fuels in areas where the hot gases from the fire could entrain radioactive materials.

4) Flammable gas fires/explosions. These are areas where the potential exists for accumulation of gaseous fuel and oxidants in flammable or explosive mixtures.

5) Overpressure. These are events that have the potential for sudden release of gases under high pressure, entraining radioactive materials in the released gases.

6) Glass spills. These events involve the spill of glass when the temperature is high enough for cesium and technetium to be volatile.

7) Toxic hazards. These events involve the release of non-radioactive toxic materials.

Table 4-28 contains the resulting list of the events judged to have potentially serious or major consequences to the public or the co-located worker. The table presents the events arranged in groups that reflect common or similar phenomena.

Table 4-28. Events with Potentially Serious or Major Consequences to the Public or Co-located Worker (Sheet 134)

Event Number	Event Identifier	System	Event Description
Loss of Confinement (liquid release)			
1	0/26	Double Shell Tank Filling	Seismic damage to transfer line
2	1614664/117	Tc Removal Using Ion Exchange	Pipe or vessel rupture
3	1/8	Entrained Solids Removal	Potential for spray leak
4	1614662/119	Cs Recovery as a Solid	Overflow of V2401 to vessel vent system
5	3200/220	LAW/HLW Melter	Overfilling or leaking of in-cell vessels
6	3200/160	LAW/HLW Melter	Failure of melter feed line
Loss of Confinement (gas or particulate release)			
7	3200/165	LAW/HLW Glass Melter	Loss of HEPA filtration because of saturation of filter by steam
8	1614667/153	Cs and Tc Nitric Acid Recovery	Enhanced radioactivity to the vent system from loss of cooling
9	3200/193	Glass melter	Contamination spread through cell
10	1614662/136	Cs Recovery as a Solid	Drop and breach of a Cs product canister
11	1614772/142	LAW Vitrification Line Product Handling	Breach of pour seal and release of melter atmosphere
12	1614775/486	Cs Line	Loss of cell atmosphere control
13	9101/10	LAW Container Decontamination	Degradation of cell HEPA due to moisture
14	1614666/129	HLW Melter Feed and Pretreatment	Loss of cooling, boiling of HLW vessel
Fire			
15	0/10	Double Shell Tank Filling	Loss of HEPA filter because of HEPA filter fire
16	1614673/288	HLW Vitrification Offgas Treatment	HEPA filter fire

Table 4-28. Events with Potentially Serious or Major Consequences to the Public or Co-located Worker (Sheet 134)

Event Number	Event Identifier	System	Event Description
17	1614700/538	Heating, Ventilation, and Air Conditioning (HVAC)	Filter fire
18	1614775/438	Cs Line	Fire initiated by plasma welding
19	1614667/119	Cs and Tc Nitric Acid Recovery	Fire in cell (ignition source present)
20	1614687/191	LAW Vitrification Emergency Offgas System	HEPA filter fire
21	1614700/511	HVAC	In-cell fire
22	3200/248	LAW/HLW Melter	Fire in melter cell
Flammable Gas Fire/Explosion			
23	1614664/117	Tc Removal Using Ion Exchange	Fire/explosion because of radiolytic hydrogen production
24	1614673/288	HLW Vitrification Offgas Treatment	Ignition of hydrogen/ammonia in process offgas
25	2200/12	Cs Removal Using Ion Exchange	Ignition of hydrogen evolved by radiolytic decomposition, or degradation of resin
26	3200/192	LAW/HLW Glass Melter	Ignition of hydrogen or carbon monoxide evolved in offgas
27	1/11 and 1/18	Entrained Solids Removal	Generation of radiolytic gases; buildup in ultrafilter and lines
28	1614661/122	LAW Melter Feed Evaporator	Fire or explosion from radiolytic hydrogen and/or ammonia in feed
29	1614661/120	LAW Melter Feed Evaporator	Combustion of ammonia, pump motor ignition source
30	1614666/122	HLW Melter Feed Receipt and Pretreatment	Radiolytic hydrogen fire/explosion; pump motor ignition source
31	1614671/339	Secondary Offgas Treatment	Hydrogen fire; electrical heater ignition source
32	1614672/238	LAW Vitrification Offgas Treatment	Ammonia fire; fan motor is ignition source, oil for burner is additional fuel
33	2200/11	Cs Removal Using Ion Exchange	Hydrogen fire in column
		LAW Vitrification Offgas	Ammonium nitrate formation because of loss of

Table 4-28. Events with Potentially Serious or Major Consequences to the Public or Co-located Worker (Sheet 134)

Event Number	Event Identifier	System	Event Description
34	1614672/239	Treatment	process parameters (temperature control) and subsequent explosion
Overpressure			
35	1614687/171	LAW Vitrification Emergency Offgas System	Breach of line because of pressure caused by chemical reaction in melter
36	3200/193	LAW/HLW Glass Melter	Failure of emergency offgas to relieve pressure
37	3200/167	HLW/LAW Melter	Overpressurization of melter vessel
38	1614662/121	Cs Recovery as a Solid	Pressurization of canister from water in canister; steam or radiolytic gases
39	1614664/120	Tc Removal Using Ion Exchange	Explosion in vessels (ion exchange columns) due to breakthrough of steam
40	1614664/118	Tc Removal Using Ion Exchange	Pressurization of vessel vent system from hydrogen (degradation of resin) or steam produced by heat from mixing caustic and acid
41	1614667/120	Cs and Tc Nitric Acid Recovery	Overpressurization of evaporator from heat generated by acid water reaction or radiolytic hydrogen production
42	2200/13	Cs Removal Using Ion Exchange	Overpressurization of column from resin degradation or resin discharge line blockage
43	2200/11	Cs Removal Using Ion Exchange	Overpressurization of column from heat generated by caustic/acid mixing or resin degradation
Glass Spill			
44	1614772/145	LAW Vitrification Line Product Handling	Use of wrong filling material
45	1614774/285	LAW/HLW Melter Maintenance	Failure of melter due to seismic event
46	1614672/224	LAW Vitrification Offgas Treatment System	Pressurization of melter; potential for loss of glass containment/involuntary glass discharge
47	3200/179	LAW/HLW Glass Melter	Loss of glass containment from corrosion
48	3200/161	LAW/HLW Glass Melter	Overfilling of melter
49	3200/246	LAW/HLW Glass Melter	Catastrophic failure in primary containment via melter refractory penetrations, thermocouple guide

Table 4-28. Events with Potentially Serious or Major Consequences to the Public or Co-located Worker (Sheet 134)

Event Number	Event Identifier	System	Event Description
			tube failure
50	3200/248	LAW/HLW Glass Melter	Glass spillage
Airborne Toxic Hazard to Public or Co-located Worker			
51	1614667/131	Cs and Tc Nitric Acid Recovery	Damage to nitric acid stock tanks
52	1614775/399	Cs Line	Spillage of nitric acid in-cell resulting in evolution of fumes
53	Cold Chemical Storage Safety Review	Bulk Cold Chemical Storage	Breach of ammonia tank, release of ammonia

4.7.1.2 Choice of Representative and Bounding Accident Scenarios{tc \l4 "4.7.1.2 Choice of Representative and Bounding Accident Scenarios}. The accident analysis derived the representative and bounding scenarios from the list of events with the most serious consequences to the workers and the public. Results from analysis of the bounding accident in a group, along with consideration of dispersal mechanisms, provided information for assessing consequences for the other scenarios in the group.

For the purpose of selecting the bounding accident scenarios for analysis, the events in a group were compared based on the potential material at risk for release. The radionuclide makeup of the materials in the postulated releases are different for each scenario. The ultimate effect of human exposure to radionuclide bearing materials varies with the radionuclide and its chemical form. Therefore, to provide a consistent basis for comparison of consequences, the inhalation dose conversion factors (EPA 1988) were applied to convert inventories to committed dose equivalent in units of sieverts (Sv).

In selecting events from the group for further accident analysis, the comparison of potential release magnitude was supplemented by consideration of the available mechanisms affecting the quantity of material available for airborne transport. Additional circumstances were considered that might increase the potential for exposure to workers and the public by pathways other than the inhalation pathway but the inhalation pathway was clearly dominated.

The following paragraphs discuss the relevant considerations for comparison of events by group, and the rationale for the choice of the representative and bounding scenarios for consequence analysis.

4.7.1.2.1 Loss of Confinement (Liquid Release). Events 1 through 6 on Table 4-28 involve liquid loss of confinement. Events 1 and 2 were assigned consequence category 3 or 4 by the hazard evaluation team. Four additional events, numbers 3 through 6, were added to the group on examination of the fault schedule for events with potentially significant releases if considered unmitigated.

Events 1, 2, 4 and 5 involve liquid spills that are phenomenologically similar in effecting a dispersion of hazardous material. The airborne entrainment of spilled liquid occurs as a result of splashing and the airflow over open pools or contaminated soil. Events 3 and 6 involve the potential for a spray release providing an alternate mechanism for airborne entrainment of radioactive materials.

The following paragraphs summarize the basis for comparing the inventory at risk for liquid loss of confinement events. Envelope B waste is taken as the bounding case for the LAW.

Event 1 - Seismic Damage to Transfer Line. LAW designated for vitrification in the TWRS-P Facility is transferred by the U.S. DOE to the existing double-shell tank 241-AP-106 via underground pipeline. Event 1, seismic damage to the transfer line, is not unique to the TWRS-P Facility operation, but also is possible in tank farm operations. The analysis of this event is found in the supporting analyses for the *Tank Waste Remediation System (TWRS) Basis for Interim Operation* (HNF 1997).

Two transfer line leak scenarios were considered for the TWRS analysis. One was a catastrophic break of a bermed line during waste transfer, chosen to represent and bound subsurface leaks resulting in a pool (Hall 1996a). This event could also be initiated by inadvertent digging with construction equipment in the area where the pipe is buried. The other scenario postulated the formation of a large surface pool resulting from misrouting waste through an open nozzle in a pump pit (Hall 1996b).

The TWRS analysis postulates that the transfer pumps continue to operate for 12 hours after the line is breached, the underground leak erodes the embankment material and a 37,500 gal (140 m^3) surface pool is formed. If the same assumptions are used for the TWRS-P transfer line, and Envelope B waste is taken as bounding, the total inhalation dose equivalent for the spill is 5.8×10^8 Sv.

The second TWRS transfer line leak scenario postulates the overflow of a transfer enclosure or pit. Again, the pumps were assumed to continue operating for 12 hours. The overflow forms a 210,000 gal (800 m^3) pool on the soil surface, providing a dose equivalent of 3.3×10^9 Sv.

Exposure to workers and the public for both scenarios considered inhalation doses from airborne entrainment from the pool surface, and from surface contamination of the soil after the liquid soaked into the ground. Direct radiation shine from the pool and contaminated soil surfaces was found to contribute significantly to the dose to the co-located worker, but to be insignificant to the public receptor dose because of distance.

The transfer line to the TWRS-P Facility is buried and double-contained. Recovery time to discontinue pumping after a line break or seismic event is much less than 12 hours. Therefore, the size of surface pool formed and resulting exposures are expected to be much less than those postulated for the TWRS bounding analysis.

Event 2 - Pipe or Vessel Rupture During Technetium or Cesium Removal. Technetium and cesium are removed from the LAW waste, each by a dedicated ion exchange operation. They are subsequently eluted from the ion exchange columns, and the eluate solution is concentrated and neutralized.

The eluate from the cesium ion exchange column provides the higher hazard, from the standpoint of potential dose, for a pipe or vessel rupture during either ion exchange operation. The bounding cesium inventory in one ion exchange cycle, based on processing of Envelope B waste, is 6.1×10^{15} Bq ^{137}Cs. The volume of eluate from one cycle is 10.5 m^3. It is conservatively assumed that solution from two elution cycles is being stored. Therefore, the inhalation dose equivalent from a double batch of cesium ion exchange eluate is 1.1×10^8 Sv. The same assumptions for the technetium ion exchange area give a dose equivalent of 7.9×10^3 Sv.

Event 3 - Spray Release During Entrained Solids Removal. LAW is delivered to the TWRS-P Facility with less than five volume percent insoluble solids fraction (DOE-RL 1996). Ultrafiltration removes the insoluble solids from the waste stream before it enters the ion exchange processes for cesium and technetium removal.

The hazard evaluation postulates a radioactive liquid release from lines in the ultrafiltration cell during maintenance activities. Inadvertent opening of a pressurized line during maintenance could result in a spray release of the LAW.

The quantity of material that becomes airborne as respirable particles from a spray release depends on the line pressure and the size and shape of the orifice through which the material is released. A comparison of the bounding ARF times the RF values for a spray with the ARF x RF for entrainment by splashing indicates that they are of similar order (DOE 1994). Therefore, it is concluded, for the purpose of this screening, that a spray release from entrained solids removal piping is bounded by Event 1, the LAW transfer line break.

Event 4 - Overflow of V2401 to the Vessel Vent System. Cesium is eluted from the ion exchange column with nitric acid. The eluate is concentrated by evaporation and transferred to the cesium concentrate receiver tank, V2401. For the LAW-Only option, the concentrate is neutralized by adding sodium hydroxide.

In this event, the cesium concentrate receiver is double batched, causing V2401 to overflow into the vessel vent system. One elution cycle of the cesium ion exchange column is reduced to 600 L during the nitric acid recovery process. Neutralization by sodium hydroxide doubles the volume. The capacity of V2401 is 1.5 m^3. If an additional batch of cesium concentrate is inadvertently added to the tank before the previous batch is processed through the CST, the total volume is 1.8 m^3 and the overflow is 300 L.

A conservative estimate of the radioactive cesium in the overflow is the bounding ^{137}Cs inventory from one ion exchange cycle of Envelope B waste. Because the overflow represents one-half of one cycle's eluate, this assumption effectively doubles the expected concentration. Therefore, the overflow is conservatively assumed to contain 6.1×10^{15} Bq ^{137}Cs, converting to an inhalation dose equivalent of 5.3×10^{7} Sv.

Event 5 - Overfilling or Leaking of In-Cell LAW/HLW Melter Vessels. Radionuclides are removed from the waste before vitrification in the LAW melter. The cesium, technetium, and strontium/TRU removed in the LAW preparation process are components of the feed for the HLW melter. These streams of radionuclide concentrates are added to the dewatered Envelope D feed in the two HLW concentrate vessels, V4107A and V4107B. Each tank has an operating capacity of 5.5 m^3 or about one-half day's production. The inhalation dose equivalent for the total inventory in both tanks is 2.6×10^{9} Sv.

Event 6 - Failure of the Melter Feed Line. The blended HLW concentrate is pumped to the melter feed preparation vessel, V4201, where it is mixed with glass formers and transferred to the melter feed tank, V4202. The radionuclide makeup of the solution is the same as in the Event 5, but the material is diluted by the addition of the glass formers. The release quantity and bounding inventory is conservatively taken to be the same as for Event 5.

Liquid Loss-of-Confinement Events Subject to Further Accident Analysis. Based on the potential consequences of inventory at risk for release, Events 1, 5 and 6 are candidates for choice of scenario for further development in accident analysis. The leak in the transfer line from tank 241-AP-106 to the TWRS-P Facility needs further investigation to determine whether the scenario developed for TWRS is credible for this operation.

A failure of one of the 225 m^3 HLW receipt tanks provides a higher inventory than any of the events considered. Therefore, a scenario postulating loss of the entire inventory of one HLW receipt tank is developed in Section 4.7.2 to bound all the liquid release events for the HLW/LAW option. For the LAW-Only option, the bounding tank inventory is a LAW receipt tank with Envelope B waste. That scenario is also developed in Section 4.7.2.

Table 4-29 summarizes the comparison of the liquid loss-of-confinement events considered.

Table 4-29. Summary of Liquid Loss of Confinement Events

Event Number	Fault Schedule Event Identifier	System	Initiating Event	Inventory Basis	Release Quantity (m^3)	Dose Equivalent (Sv)
1	0/26	Transfer line between 241-AP-106 and TWRS-P	Line break, leak to soil	LAW Envelope B	140	5.8×10^8
			Leak into transfer pit		800	3.3×10^9
2	1614664/117	Tc Product Tank	Leak	Two cycles Tc ion exchange eluate	21	7.9×10^3
		Cs Product Tank		Two cycles Cs ion exchange eluate	21	1.1×10^8
3	1/8	Entrained Solids Removal Piping	Spray leak	LAW Envelope B	Bounded by transfer line break (0/26)	
4	1614662/119	Cs Neutralization Tank (V2401)	Overflow	Double the expected ^{137}Cs concentration in one ion exchange cycle	0.300	5.3×10^7
5	3200/220	HLW Melter Feed Vessel[1]	Leak	Dewatered Envelope D waste plus Tc, Cs and Sr/TRU removed from LAW	5.5	1.3×10^9
6	3200/160	HLW Melter Feed Line[1]	Line break, possible spray leak			
No number	No number	LAW Receipt Tank	Leak	Envelope B waste	200	8.3×10^8
No number	No number	HLW Receipt Tank[1]	Leak	Envelope D waste	225	3.8×10^{10}

[1] HLW/LAW option only

4.7.1.2.2 Loss of Confinement (Gas or Particulate Release){tc \l5 "4.7.1.2.2 Loss of Confinement (Gas or Particulate Release)}. The events in this group involve either release of gases that contain radioactive or toxic material as vapors or entrained particulates, or suspension of solid material in airflows. Events 7, 8 and 9 in Table 4-28 were assigned consequence category 3 or 4 by the hazard evaluation team. Events 10 through 14 are judged to have potentially high enough consequences, if unmitigated, to warrant consideration in selecting representative and bounding accident scenarios.

Events 7, 9, and 11 - Release of Melter Gases. Events 7, 9, and 11 involve an uncontrolled release of melter gases. Process flow diagrams indicate the quantity of radionuclides that will be in the HLW melter gas stream on a daily flowthrough.

For Event 7, loss of HEPA filtration because of saturation of the filter by steam, it is assumed that the release continues for 24 hours before detection. Therefore, the total release quantity converted to dose equivalents is 2.4×10^6 Sv.

Events 9 and 11 involve the release of the gasses in the melter at the time of the event. Process flow diagrams indicate that the daily gas flow is 4.8×10^4 m^3/day. The free volume of the melter is about 6.4 m^3. Therefore, the radionuclide quantity in the melter gases converted to inhalation dose equivalent is expected to be 320 Sv.

Events 12 and 13 - Loss of Cell Atmosphere Control. Events 12 and 13 postulate uncontrolled release of contaminated cell atmosphere. In Event 12, airborne contamination from the cesium product line is drawn into occupied areas by loss of ventilation control. Event 13 proposes a release of contaminated atmosphere from the ILAW or IHLW container decontamination cell to the downstream ventilation system because of degradation of the HEPA filter by moisture.

The potential release from each of these events is expected to be low. Good housekeeping and monitoring will keep the normal loading of airborne contaminants in the cesium product line cell below levels of concern for potential release outside the building. A release into an occupied area must be tracked as a concern for the safety of the facility worker.

The container decontamination cell atmosphere may contain water mists with entrained contaminants washed from the external surface of the vitrified waste containers. Significant external contamination of the containers is not expected. Therefore, the radionuclide quantities released by degradation of the filter are expected to be orders of magnitude lower than the other events in the group and are assumed to be bounded by the melter gas release events.

Events 8 and 14 - Tank Boiling. Events 8 and 14 postulate entrainment of vapors in airflows because of unplanned liquid boiling. Vessels with high radionuclide loading are provided with cooling systems to control temperature. Loss of cooling allows the temperature of the tank contents to increase. If cooling is lost for a sufficient time, the contents may boil. Radionuclides and toxic components in the solution are entrained in the vapors given off during boiling.

The heat load of the tank, the amount of liquid, the heat capacity of the contents, and the geometry of the tank influence whether the tank will boil, the time required to reach the boiling temperature, and the time required to boil to dryness. For the purpose of this analysis, it is assumed that the tanks will boil and the bounding case is the tank with the higher heat load concentration.

The two tanks proposed by the hazard evaluation team to have a potential for significant release from boiling contents are V2710 in the technetium nitric acid recovery system, and V4107A or B in the HLW melter pretreatment and feed system. For the HLW/LAW option, V2710 receives the concentrated eluate from both technetium and cesium ion exchange. The maximum design volume of V2710 is 56.2 m^3. The maximum radionuclide inventory is 200,000 TBq ^{137}Cs and 900 TBq ^{99}Tc. The inhalation dose equivalents are 1.7×10^9 Sv ^{137}Cs and 2.0×10^6 Sv ^{99}Tc, for a total of 1.7×10^9 Sv. The total heat load is 26,000 W or 460 W/m^3.

Tanks 4107A and B were described, and their maximum tank inventories given, in Section 4.7.1.2.1. Each tank has an operating capacity of 5.5 m^3 and the committed dose equivalent for the total inventory in the two tanks is 2.6×10^9 Sv, or 1.3×10^9 Sv in one tank. The total heat load is 1700 W or 310 W/m^3.

Event 10 - Drop and Breach of a Cesium Product Canister. Event 10 describes a release of the cesium product, cesium adsorbed on CST, when a product canister is dropped while being moved. The maximum ^{137}Cs loading of a product canister is 6000 TBq, which equates to 5.2×10^7 Sv.

Loss-of-Confinement Events Leading to Gas or Particulate Release Subject to Further Accident Analysis. Table 4-30 summarizes the comparison of the loss-of-confinement events leading to gas or particulate release.

Two scenarios from this group, drop and breach of a cesium product canister and tank boiling, are further developed in Section 4.7.2. Loss of cooling to tank V2710 is chosen to bound the tank boiling scenarios because the heat load concentration is greater.

4.7.1.2.3 Fire. Events 15 through 18 on Table 4-28, were assigned by the hazard evaluation team to consequence category 3 or 4. Four additional fire events, initially assigned consequence category 2, were added to the group (Events 19 through 22 in Table 4-28) for consideration as bounding events for accident analysis.

High Efficiency Particulate Air (HEPA) Filter Fire Scenarios. HEPA filters are a common feature of the TWRS-P Facility ventilation systems. The hazard evaluation team, in the review of TWRS-P Facility, found that a fire in a filter was an event that represented a potentially significant risk to the workers and the public. The potential filter fire events are Events 15, 16, 17, and 20 in Table 4-28.

The filter medium of a HEPA filter is a fine diameter glass fiber that softens and melts when heated, but does not support a fire in itself (DOE 1994). A source of fuel occluded on the filter is necessary for a fire in a filter to occur. Fires in filters are of concern because the temperatures generated by combustion of flammable materials on the filter could volatilize and release radionuclides deposited on the filter, or cause the filter medium to fail.

Table 4-30. Summary of Loss of Confinement Events Leading to Gas or Particulate Release

Event Number	Event Identifier	System	Initiating Event	Inventory Basis	Quantity	Dose Equivalent (Sv)
7	3200/165	Melter Plenum	Degradation of HEPA filter by steam	Melter plenum gases	4.8×10^4 m^3	2.4 x 10 6
8	1614667/153	Tank V2710	Loss of cooling	Values provided in Chapter 4.0 of the Hazard Analysis Report	56.2 m^3	1.7×10^9
9	3200/193	Melter	Failure of emergency offgas to relieve	Melter plenum gases	6.4 m 3	320
10	1614662/136	Cs Product Canister	Drop	One product canister	46 L CST with maximum cesium loading	5.2×10^7
11	1614772/142	Melter	Breach of pour seal	Melter plenum gases	6.4 m 3	320
12	1614775/486	Cs Line	Loss of ventilation balance	Cesium cell atmosphere	Bounded by melter gas releases.	
13	9101/10	Glass Product Container Decontaminati on Cell	Loss or degradation of HEPA filter	Decontamination cell atmosphere	Bounded by melter gas releases.	
14	1614666/129	V4107	Loss of cooling	Dewatered Envelope D waste plus Tc, Cs and Sr/TRU removed from LAW	5.5 m^3	1.3×10^9

Fuel sources that have supported filter fires, or that have raised concern for filter fires at other facilities, are ammonia and ammonium nitrate, and liquid organic vapors. None of the waste envelopes to be treated by the TWRS-P Facility contains a volatile liquid organic phase. The pretreatment and vitrification processes do not introduce volatile organic liquids. Therefore, accumulation of these compounds as a source of combustion on filters is not a concern.

Ammonia has been detected in the tank farm ventilation systems and may be present in solution in the liquid wastes transferred to the TWRS-P Facility. This leads to a concern that ammonium nitrate precipitation on the HEPA filters could support a fire or explosion. Safety assessments for the tank farms (Pederson and Bryan 1994, Borscheim and Kirch 1991) and the Purex facility (Walser 1980), and experience at the Savannah River Defense Waste Processing Facility (DWPF) (DuPont 1988) indicate that the potential for ammonium nitrate precipitation on filters, and subsequent combustion, is low.

Based on the findings of these reports, the filter fire events are dropped from the list of accidents having sufficient risk to the worker and the public to require consequence analysis.

Event 18 - Fire Initiated by Plasma Welding. Event 18 postulates a fire initiated by the welding operation on the cesium product canister. The combustible loading in the area is limited by design and by administrative control. Actual fire loading estimates and fire hazard evaluation are activities that will be included as design progresses.

In the absence of a fire hazard evaluation, potential inventories of combustibles are postulated. Mineral oil is typically used to provide acceptable visibility in shielding windows. Oil leakage from the fill and drain connections on the windows could provide a source of fuel. However, these connections are on the manned side of the window rather than into the cell. The shield windows are lead-impregnated glass blocks, staggered to eliminate direct shine paths. There is a thin layer of oil between the blocks, but the total volume of oil is on the order of a few liters. A catastrophic failure that allows all the oil to drain is unlikely. A fire would result in property damage, and perhaps operator burns, but not a radioactive release.

Another possibility is a fire ignited in a waste container by the plasma welder or hot scrap. Conventional handling of radioactive waste containers limits the surface dose to less than 200 mrem/hr. A surface dose exceeding this criterion must be remotely handled (WHC 1993).

A high radiation container would not be detected until it was fully loaded, sealed, and ready to be removed from the cell. The measurement of surface dose is performed in the cell before the container is moved through the airlock. Assume that the fire occurs in a cesium line waste container with a surface dose an order of magnitude higher than the 200 mrem/hr, or 2 rem/hr at 0.3 meters. The quantity of ^{137}Cs in the burning waste is roughly 2 Ci (7.4×10^{10} Bq), with an inhalation dose equivalent of 6.4×10^{4} Sv.

Event 19 - Fire in Cell (Ignition Source Present). The hazard evaluation team postulated that combustible materials in the cesium and technetium nitric acid recovery area contact an ignition source. Process flow diagrams were reviewed for the ignition sources mentioned by the consequence description of this event. Nitric acid can increase the potential for organic materials to ignite.

Ion exchange operations for cesium and technetium removal are connected to the nitric acid recovery areas by the ion exchange eluate lines. In the event of a failure of the resin support screen, cesium or technetium ion exchange resin could leak into the eluate and be transferred to the acid recovery system. Accumulation and drying of this nitrated resin in the acid recovery vessels, or in the cell, is a potential fire hazard.

Concentrated cesium produced in the cesium nitric acid recovery system is neutralized to enhance the sorption of cesium on CST. Any ion exchange resin carry over to this point in the process

would react violently if it were converted from the nitrate form to hydroxide form in a neutralization reaction.
The source term for this accident is bounded by a scenario involving fire in a cesium ion exchange column discussed in the event group AFlammable Gas Fire/Explosion.@

Event 21 - In-cell Fire. This event is classified as a generic process fire. Potential initiators of fires in hot cell operations include electrical shorts, spontaneous combustion, friction, hot process equipment and minor explosions.

A fire hazard evaluation and an estimate of the fire loading is necessary to definitively determine the fire hazard. It is assumed that in lieu of the fire hazard evaluation, which will be performed prior to facility startup, the bounding fire event is the resin or melter fire. This assertion will be verified in a later safety analysis.

Event 22 - Fire in Melter Cell. The ion exchange capacity of the resins decreases with use and the spent resin must be replaced with fresh resin. Spent resin is normally low in radioactivity and is transferred to the LAW melter. Spent resin that is out-of-specification for radioactive content is transferred to the HLW melter. The temperature in the melter plenum ignites and burns the organic resin matrix and the ions sorbed on the ion exchange sites are incorporated in the glass.

The melter feed, a slurry of glass formers and waste, erodes the feed nozzle and transfer piping; hence, leaks are to be expected. Resin in the leak being lighter than the other constituents may tend to separate and accumulate in the hot area near or on the melter. The out-of-specification resin sent to the HLW melter may have performed poorly during elution, in the bounding case retaining cesium at a level near full capacity. The source term for this accident is bounded by a scenario involving fire in a cesium ion exchange column discussed in the event group AFlammable Gas Fire/Explosion.@

4.7.1.2.4 Flammable Gas Fire/Explosion. Five flammable gas fire/explosions, Events 23 through 26 in Table 4-28, were assigned by the hazard evaluation team to consequence category 3 or 4. Eight additional flammable gas fire/explosion events, initially assigned consequence category 2, were added to the group (Events 27 through 34 in Table 4-28) for consideration as bounding events for accident analysis.

Events 23, 25 and 33 - Resin Degradation Resulting in Generation of Flammable Gases. The hazard evaluation team postulated that radiolytic degradation of ion exchange resin in either the technetium or the cesium ion exchange process could generate flammable or explosive gases resulting in dispersal of radioactive materials.

Process descriptions tie the quantity of LAW processed in one ion exchange cycle to the estimated maximum column loading capability. Twenty column volumes of Envelope B waste are processed in a cesium ion exchange cycle. For technetium ion exchange, the ion exchange capacity of 50 column volumes is constant for all waste. For both systems one column volume is 1.05 m^3.

Assuming a sodium concentration of 7M sodium and 20 column volumes of Envelope B waste, the column capacity is 8.8×10^{15} Bq. The peak ^{137}Cs loading on the ion exchange column from the processing of Envelope B waste converts to an inhalation dose equivalent of 7.6×10^{7} Sv.

The ^{99}Tc concentration is the same for the three waste envelopes, 7.1 x 10^{6} Bq/mole of sodium. Assuming a 7M sodium feed and a feed volume of 50 column volumes per cycle gives a column capacity of 2.6 x 10^{12} Bq ^{99}Tc. The inhalation dose equivalent from the fully loaded ion exchange column is 5900 Sv.

Event 33, another cesium ion exchange event in the flammable gas fire/explosion category, postulates a specific mechanism, a fire. The consequence analysis of these ion exchange accidents estimates an upper bound mechanism of fire, explosive release or a combination of these two phenomena.

Events 24, 26 and 31 - Melter Offgas Fire/Explosion. Events 24 and 26 are treated together because they both involve the presence of flammable gases in the HLW melter offgas system. Event 31 postulates a fire in the secondary offgas treatment system.

A blast or shock wave from an explosion acts to dislodge and disperse radioactivity that has accumulated in the melter plenum and melter offgas system. A melter offgas filter blowout is assumed as the source of the release for this event.

Particulates in the offgas from the HLW melter are removed from the hot melter offgas by the venturi scrubber, the HEME and the metal fiber HEPA filter. These are points for radioactivity to accumulate in the melter offgas system. Melter particulates are entrained in an aqueous slurry by the venturi scrubber. The mist and entrained droplets from the venturi scrubber collect in the drainage from the HEME.

Radioactive dry powder accumulating on the HEPA filter in the melter offgas system is more easily made airborne than the aqueous slurry of melter particulates in the venturi scrubber quench solution. The metal wire media of HEPA filters are washed at regular intervals. It is assumed that the metal HEPA filter has a particulate loading consistent with that observed for fiberglass filters at change out.

A conservative value for filter accumulation is 69.8 g (DOE 1994). ^{137}Cs and ^{99}Tc are semi-volatile radioactive species that are vaporized in the HLW melter and form fine particulates upon cooling in the melter offgas system. Assuming the deposited material is all cesium, the cesium source term for this event is 5.6 x 10^{13} Bq. This source term, in terms of the inhalation dose, is equivalent to 480,000 Sv.

The maximum releases for these events bound those for Event 31, a hydrogen fire caused by electrical heater ignition in the Secondary Offgas Treatment System. The filter involved in this event is the treated offgas filter. Manual change out of this filter limits particulate loading to a much lower value than estimated in the analysis occurring in the primary offgas systems.

Event 27 - Ultrafilter Explosion. Event 27 is caused by the buildup of radiolytic hydrogen in the ultrafilter and lines of the entrained solids removal process. Ultrafiltration is used to remove entrained solids and precipitated strontium/transuranic (TRU) solids from the LAW feed to ion exchange, and to dewater the Envelope D feed to the HLW melter.

Envelope D waste contains a higher proportion of radionuclide bearing solids than any of the LAW feed envelopes. The hazard presented by a buildup of radiolytic hydrogen in the ultrafilter and lines is greatest for the dewatering operation.

The ultrafilter is 520 mm in diameter and 1170 mm long with a volume of 248.5 liter. The accumulation of radionuclides on the ultrafilter, estimated from the TWRS-P Facility flowsheet concentrations in the dewatered sludge, gives an inhalation dose equivalent of 1.5×10^8 Sv.

This event warrants further investigation as a potential scenario and requires further analysis. The specifics of the accident phenomenology must be brought into the analysis to determine the quantity of hazardous material released.

Events 28 and 29 - Fire or Explosion in the LAW Melter Feed Evaporator System. Events 28 and 29 in Table 4-28 represent the same event, a flammable gas fire/explosion in the LAW melter feed evaporator. The LAW melter feed evaporator concentrates pretreated LAW solutions from ion exchange to specified sodium concentration.

Steam ejectors draw a vacuum and vent the condensable and non-condensable gas from the LAW melter evaporator. Failure of the steam ejectors would cause the evaporator to pressurize through the reverse steam flow or would accumulate flammable gas (i.e., hydrogen) simply through the loss of the means to vent the evaporator.

The TWRS-P Facility flowsheet concentration of radionuclides for the material in the LAW melter feed evaporator, converted to inhalation dose equivalent, is 5100 Sv.

Event 30 - HLW Melter Feed Receipt and Pretreatment Explosion. Event 30 is a hydrogen fire/explosion that occurs in the HLW melter feed receipt and pretreatment area. The ignition source is a pump motor major failure.

The greatest radiolytic hydrogen generation rate in the HLW melter feed receipt and pretreatment process is in the vessels with the highest radionuclide inventory, the HLW feed blending vessels, V4107 A/B. Because the tanks are ventilated, the event requires a sustained ventilation system failure to allow radiolytic hydrogen and oxygen to accumulate. The hazardous inventory in these vessels is estimated to give an inhalation dose equivalent of 1.3×10^9 Sv for each tank. A vapor space explosion in one of these tanks is expected to involve only a portion of the liquid contents of the tank.

Events 32 and 34 - Vitrification Offgas Treatment Ammonia Fire. In LAW vitrification offgas treatment, anhydrous ammonia reacts with NO_x in the presence of a catalyst to form nitrogen gas and water vapor. This process is called SCR. Events 32 and 34 in Table 4-28, are the result of failures or abnormal operation of the SCR unit. Event 32 postulates an ammonia fire ignited by a fan motor. Fuel oil for the offgas heater is a combustible material that could contribute to the intensity of the fire. In Event 34, the loss of SCR temperature control causes the formation of ammonium nitrate and a subsequent explosion.

The immediate radiological hazard from this event is the radionuclide loading of the SCR catalyst bed. Heat from a cell fire or the blast effects from an explosion effects a dispersion of this material. The data necessary to definitively quantify the radiological hazard will be available at a future stage of design. A definitive analysis of secondary releases caused by collateral damage to an adjoining cell is also deferred to consideration for future accident analysis.

Therefore, it is conservatively assumed that a plugged SCR removes cesium particulates with a comparable efficiency to a HEPA filter. The hazard from the material on the offgas system filter was estimated to be 480,000 Sv.

Flammable Gas Fire/Explosion Events Subject to Further Analysis. Table 4-31 summarizes the comparison of the flammable gas fire/explosion events considered.

Table 4-31. Summary of Flammable Gas Fire/Explosion Events

Event Number	Event Identifier	System	Initiating Event	Inventory Basis	Quantity	Dose Equivalent (Sv)
23	1614664/117	Tc Ion Exchange Column	Resin degradation and generation of flammable gases	^{99}Tc deposited on fully loaded ion exchange column	2.6 x 10^{1}2 Bq	5900
25 and 33	2200/12 2200/11	Cs Ion Exchange Column	Resin degradation and generation of flammable gases	^{137}Cs deposited on fully loaded ion exchange column	8.8 x 10^{1}5 Bq	7.6 x 10^{7}
24, 26 and 31	1614673/288 3200/192 1614671/339	HLW Vitrification Offgas Treatment	Explosion	HLW Melter offgas	5.6 x 10^{13} Bq	4.8 x 105
27	1/11 1/18	Entrained Solids Removal Ultrafilter	Explosion	Dewatered Envelope D waste	248.5 L	1.5 x 10^{8}
28 and 29	1614661/122 1614661/120	LAW Melter Feed Evaporator	Fire or explosion	Envelope B melter feed	7.84 m^{3}	5100
30	1614666/122	HLW Melter Feed Receipt and Pretreatment	Flammable gas vapor space explosion	Dewatered Envelope D waste plus Tc, Cs and Sr/TRU removed from LAW	5.5 m^{3}	1.3 x 109
32 and 34	1614672/238 1614672/239	HLW or LAW Vitrification Offgas Treatment	Ammonia fire, ammonium nitrate explosion	Cesium particulate loading on offgas system filter	5.6 x 10^{13} Bq	4.8 x 10^{5}

Based on the potential consequences of inventory at risk for release, Events 27, 30, and 25/33 are candidates for choice of scenario for further development in accident analysis. The mechanisms leading to material release from the flammable gas fire/explosion scenarios are highly dependent on the initial conditions and geometry of the systems involved. Therefore, selecting the bounding scenarios on the single basis of inventory-at-risk is not appropriate.

A resin degradation reaction leading to failure and release from the cesium ion exchange column is chosen to represent this group of events, and the scenario is developed in Section 4.7.2. Potential flammable gas accumulation and explosion in the vapor space of the HLW melter feed tank (Event 30) is expected to involve primarily the release of vapor space gases and a minor quantity of the concentrated waste. That event, and the potential releases from a flammable gas explosion in the HLW ultrafilter need further quantification as the design develops to verify that the consequences are bounded by the cesium column release scenario.

4.7.1.2.5 Overpressure{tc \l5 "4.7.1.2.5 Overpressure}. The events in this group postulate overpressure relief as the initiator for hazardous radioactive releases. The hazard evaluation team identified Events 35 and 36 in Table 4-28 as having potentially major or serious consequences to the public or co-located worker. Events 37 through 43 are additional overpressure events that were added when unmitigated consequences were considered.

Some of the events in this group are the same or similar to events already considered as loss of confinement events or flammable gas fire/explosion events. The quantity of material available for release from these events is the same as for the events considered in the other two groups. However, gases under pressure provide a different dispersal mechanism. Therefore, the events are reconsidered for their potential for releases initiated from high pressure differentials.

Events 35, 36, and 37 - Pressurized Release of Melter Offgas. Events 35, 36, and 37 postulate a range of overpressure events involving melter offgas. In Event 35, a chemical reaction in the melter generates sufficient pressure to cause a line breach. In Event 36, the emergency offgas system fails to relieve the pressure in the melter and the melter offgas treatment system. Event 37 postulates an overpressurization of the melter vessel from an unspecified cause.

The bounding melter overpressure event is a steam explosion caused by intimate mixing of an aqueous slurry with molten glass. This is an event addressed in the safety analyses of both the DWPF (WSRC 1997) and the West Valley Demonstration Project (WVDP) (WVNS 1995) and identified in Chapter 4 of the Hazard Analysis Report (BNFL 1997a) as an event that should be investigated for its potential in the TWRS-P Facility.

Both the DWPF and the WVDP analyses show that, because of high glass density and viscosity, and the presence of a cold cap on the glass surface, the fragmentation and mixing that are necessary conditions for a steam explosion do not exist in the melters. The melter steam explosion is considered beyond extremely unlikely, and may be considered a candidate for severe accident analysis in a future design stage. The WVDP analysis further contends that, if the steam explosion were to occur, the bounding result would be melter failure and spill of the glass contents. Postulated spills of melter contents are discussed with the group AGlass Spills@.

A HLW melter contains 5.6 m^3 (1.5 kgal) of glass. The TWRS-P Facility flowsheet gives predicted concentrations for the major radionuclides in the melter glass. The total inhalation dose equivalent from the molten glass in the melter is 5.0×10^{10} Sv.

Event 38 - Pressurization of a Cesium Product Canister. In the LAW-Only option, the cesium final product form is the inorganic ion exchanger CST with cesium sorbed at the ion exchange sites. The cesium-loaded CST is dried, sealed into canisters, overpacked and shipped to DOE.

Event 38 postulates a malfunction in the preparation of the cesium final product. Water sealed in the canisters, because of incomplete drying, could vaporize from radioactive decay heat. Radiation also dissociates any water in the canisters into hydrogen and oxygen.

Each CST canister has a maximum cesium-137 loading of 6.0×10^{15} Bq. The cesium inhalation dose equivalent from the failure of a single canister is 5.2×10^7 Sv.

Events 39, 40, 42, and 43 - Ion Exchange Column Overpressure - Events 39 and 40 in technetium ion exchange, and Events 42 and 43 in cesium ion exchange, postulate overpressurization of the ion exchange columns caused by: 1) resin degradation; or 2) a caustic-acid reaction in the resin. The consequence descriptions are the same for both the cesium and the technetium ion exchange systems. Discharge line blockage exacerbates the situation. The consequence of the resulting overpressure situation is bounded by the consequence of a fire or explosion in the column.

Event 41 - Overpressurization of an Evaporator. Event 41 postulates an uncontrolled reaction in either the cesium or technetium nitric acid recovery evaporator. Pressurization caused by uncontrolled reactions manifests itself as an explosion, a sudden loss of part of the contents of a vessel, foaming, boilover, gassing, or simply undesirable high temperature resulting in excessive evolution of contaminated vapors.

Possible initiating events are: 1) heat generated due to an acid/water reaction; 2) inadvertent transfer of ion exchange resin during elution to the evaporator; and 3) generation of hydrogen by radiolysis. The consequences are a potential release from the cell and an increase in the operator inhalation dose.

The cesium evaporator presents the greater hazard to the public and the worker of the three because of the higher radioactive concentration of the material. The product of the cesium nitric acid recovery evaporator was identified in Event 8 as the source term for a potential boiling event in the product tank. The concentration is 3.5×10^{15} Bq/m^3; the volume of the evaporator is 2.42 m^3. Therefore, the cesium nitric acid recovery evaporator contains 8.6×10^{15} Bq of cesium-137, and the hazard represented by this inventory in terms of the inhalation dose equivalent is 7.4×10^7 Sv.

Overpressure Events Subject to Further Accident Analysis. Event 38, pressurized release from a cesium product canister is selected for further scenario development in Section 4.7.2. Event 37, overpressure in the melter vessel is bounded by a melter failure and glass spill event considered in the next section. Events 42 and 43, pressurization of the cesium ion exchange column, are covered in the analysis of the cesium ion exchange exotherm selected to represent the flammable gas fire/explosion group.

Table 4-32 summarizes the comparison of the overpressure events that were considered for further analysis.

Table 4-32. Summary of Overpressure Events

Event Number	Event Identifier	System	Initiating Event	Inventory Basis	Quantity	Dose Equivalent (Sv)
35	1614687/171	LAW Vitrification Emergency Offgas	Chemical reaction in melter	Melter plenum gases	4.8 x 10^4 m^3	2.4 x 10 6
36	3200/193	LAW/HLW glass melter	Failure of emergency offgas to relieve	Melter plenum gases	6.4 m 3	275
37	3200/167	LAW/HLW glass melter	Overpressure in melter vessel	Glass contents of HLW melter	5.6 m 3	6.0 x 10^{10}
38	1614662/121	Cs recovery as a solid	Inadequate drying of cesium canister	One Cs product canister	6.0 x 10^{15} Bq ^{137}Cs	5.0 x 10^7
39	1614664/120	Tc ion exchange	Steam breakthrough	^{99}Tc deposited on fully loaded ion exchange column	2.6 x 10^{12} Bq	5900
40	1614664/118	Tc ion exchange	Hydrogen or steam generation from caustic/acid mixing	^{99}Tc deposited on fully loaded ion exchange column	2.6 x 10^{12} Bq	5900
41	1614667/120	Cs or Tc nitric acid recovery	Acid/water reaction or radiolytic hydrogen production	Concentrated Cs ion exchange eluate	2.42 m^3	7.4 x 10^7
42	2200/13	Cs ion exchange	Column overpressure from resin degradation	^{137}Cs deposited on fully loaded ion exchange column	8.8 x 10^{15} Bq	7.6 x 10^7
43	2200/11	Cs ion exchange	Column overpressure from	^{137}Cs deposited on fully loaded ion exchange column	8.8 x 10^{15} Bq	7.6 x 10^7

Table 4-32. Summary of Overpressure Events

Event Number	Event Identifier	System	Initiating Event	Inventory Basis	Quantity	Dose Equivalent (Sv)
			caustic/acid mixing			

4.7.1.2.6 Glass Spill{tc \l5 "4.7.1.2.6 Glass Spill}. Events 44 through 50 in Table 4-28 are events with the potential for release of molten glass. Events 44 and 45 were identified by the hazard evaluation team among the events with potential for serious or major consequences. Events 46 through 50 were added after consideration of the potential unmitigated consequences.

Event 44 - Use of Wrong Filling Material in the LAW Vitrification Product Handling. In the LAW Vitrification Line Product Handling operation, the LAW containers are filled to a maximum without overflowing, allowed to cool, and filled to capacity with an inert material. Event 44 postulates that, because of an operator error the wrong filler material is used.

The composition of the inert material has not been finalized. Two likely possibilities are sand and grout. The Awrong@ material that could be inadvertently substituted for the filler material would most likely be another solid material used elsewhere in the facility.

The possible reactions of glass with other solids was investigated by reviewing glass incidents in Bretherick's Handbook of Reactive Chemical Hazards (Bretherick 1990). Copper (II) oxide is one of the chemicals used to formulate glass in the TWRS-P Facility. An exothermic reaction that melted the glass container was reported when a mixture containing copper (II) oxide was heated. Inadvertently adding ion exchange resin as filler material is another possibility. It is a less likely scenario, however, because of the dissimilar appearance of resin and the proposed filler materials, the difference in the way the materials are packaged, and the different facility locations where the materials are stored and used.

The most likely scenario is an operator mistakenly adds copper oxide to fill a glass container to capacity. If the glass has been insufficiently cooled, the exothermic reaction of copper oxide and glass causes the glass to melt. The container with molten glass is removed from the pouring station and the lid fitted to the container. The consequence of Event 37 is bounded by the worst case glass spill event.

Glass Spill from Melter. Events 45 through 50 in Table 4-28 are those that are postulated to result in a spill of molten glass into the melter cell. A variety of initiating circumstances, with a range of potential spill quantities, are postulated.

The HLW melter contents bound the LAW melter potential releases because the radionuclide loading of the IHLW is orders of magnitude greater than the ILAW. For the LAW-Only option, a glass spill from the operating melter may have implications for worker safety and operations, but is not expected to result in significant releases affecting the public or co-located worker.

Glass Spill Event Subject to Further Analysis. Failure of the melter with release of the entire glass contents at operating temperature is the maximum result of Event 47, and bounds the remaining events. That scenario is further developed in Section 4.7.2.

4.7.1.2.7 Release of Toxic Materials. The hazard evaluation team, in their examination of the process modules, identified two events that involve nitric acid spills in-cell. Hazards associated with the bulk cold chemical storage were assessed in a separate safety review. That review identified a spill from the 12.2M nitric acid bulk storage tank. Failure of that tank is chosen for further development in Section 4.7.2 because it contains the highest concentration of nitric acid in the greatest quantity, and it is located outside the facility so there are no barriers to mitigate transport to receptors. The tank contains 5000 gallons of 12.2M (18.9 m^3) nitric acid.

A leak from the 15.5 m^3 anhydrous ammonia supply tank was also postulated in the bulk chemical storage safety review. The tank holds 25,000 lb (1.1 x 10^4 kg) liquefied anhydrous ammonia. That scenario is also chosen for further development in Section 4.7.2.

4.7.1.3 Summary of Bounding Accident Scenarios{tc \l4 "4.7.1.3 Summary of Bounding Accident Scenarios}. Table 4-33 summarizes the accident scenarios selected to represent each group and bound the accident consequences for the LAW only option and the HLW/LAW combined option. The section numbers where the analysis is found are given for each scenario.

Table 4-33. Summary of Selected Accident Scenarios

Group	Representative and Bounding Scenario LAW only option		Representative and Bounding Scenario HLW/LAW option	
	Event Number	Scenario	Event Number	Scenario
Loss of confinement (liquid release)	None	Section 4.7.2.1 - LAW receipt tank failure	None	Section 4.7.2.2 - HLW receipt tank failure
Loss of confinement (gas or particulate release)	10	Section 4.7.2.3 - Drop of cesium product canister	8	Section 4.7.2.4 - Boiling of technetium/cesium product storage tank
Fire	No scenarios for analysis identified, all events bounded by the flammable gas fire scenario.			
Flammable gas fire/explosion	25 and 33	Section 4.7.2.5 - Cesium ion exchange column exothermic reaction	25 and 33	Section 4.7.2.5 - Cesium ion exchange column exothermic reaction
Overpressure	38	Section 4.7.2.6 - Pressurized release from a cesium product canister	None	None analyzed. Bounded by other scenarios.
	No			Section 4.7.2.7 - HLW

Table 4-33. Summary of Selected Accident Scenarios

Group	Representative and Bounding Scenario LAW only option		Representative and Bounding Scenario HLW/LAW option	
	Event Number	**Scenario**	**Event Number**	**Scenario**
Glass Spill	analysis	No analysis	47	melter failure
Toxic release	53	Section 4.7.2.8 - Breach of ammonia tank or feed lines	53	Section 4.7.2.8 - Breach of ammonia tank or feed lines
Toxic release	Bounds events 51 and 52	Section 4.7.2.9 - Breach of nitric acid storage tank	Bounds events 51 and 52	Section 4.7.2.9 - Breach of nitric acid storage tank
Design Basis Earthquake	None	Section 4.7.2.10 - Multiple system failures	None	Section 4.7.2.10 - Multiple system failures

4.7.2 Accidents{tc \l3 "4.7.2 Accidents}

This section provides the accident sequences chosen from the candidate accident scenarios. The results of consequence analysis are provided and compared to the radiological exposure standards given in Table 4-27. The estimated frequency of the initiating events for all the accidents are taken to be in the unlikely or extremely unlikely frequency ranges. Therefore, for the purpose of identifying requirements for Design Class I and II SSCs, the radiological exposures are compared to the exposure standards for the unlikely frequency category. For public protection, 5 rem/event is the standard. For the co-located worker, 25 rem/event is the standard.

Table 4-34 summarizes the material at risk, ARF, RF and other important assumptions inherent in the analysis.

Table 4-34. Summary of Source Terms, Release Fractions, and Assumptions for Accident Analysis (Sheet 156)

Section	Accident Scenario	Source Term	Respirable Release Fraction (ARF x RF)	Assumptions
4.7.2.1	LAW Receipt Tank Failure (Both options)	200 m^3 Envelope B Waste; ULD = 4.15 x 10^3 Sv/L	$ Free fall during spill- 1 x 10^{-4} $ Resuspension from pool - 9.6 x 10^{-6}	$ Entire contents of tank involved in spill $ Basis for ULD is contract specification and 7M sodium $ Spill from less than 3 m height $ 24 hours resuspension from the pool
4.7.2.2	HLW Receipt Tank Failure (HLW/LAW option)	225 m^3 Envelope D Waste; ULD = 1.68 x 10^5 Sv/L	$ Free fall during spill- 4 x 10^{-5} $ Resuspension from pool - 9.6 x 10^{-6}	$ Entire contents of tank involved in spill $ Basis for ULD is contract specification $ ARF x RF assumes slurry values based on high solids content of HLW and physical data for 241-AZ-101 waste $ Spill from less than 3 m height $ 24 hours resuspension from the pool
4.7.2.3	Cesium Product Canister Drop and Spill (LAW only option)	One cesium product canister with maximum loading - 6000 TBq ^{137}Cs	6.0 x 10^{-4}	$ Canister is dropped before closure and overpack $ Modeled as spill of free flowing powder
4.7.2.4	Technetium/cesium Product Tank Boiling (HLW/LAW option)	56.2 m^3 concentrated ion exchange eluate - 200,000 TBq ^{137}Cs 900 TBq ^{99}Tc	2 x 10^{-3}	$ The tank can boil before restoration of cooling occurs $ Recovery occurs before the tank boils to dryness
4.7.2.5	Cesium Ion Exchange Loss of Cooling (Both options)	^{137}Cs content of 20 column volumes Envelope B waste	$ Release of hot gases and resin from the column - 0.01 $ Flashing spray release of eluate - 0.033	$ Fully loaded ion exchange column during elution at peak eluate concentration $ Degraded resin

Table 4-34. Summary of Source Terms, Release Fractions, and Assumptions for Accident Analysis (Sheet 156)

Section	Accident Scenario	Source Term	Respirable Release Fraction (ARF x RF)	Assumptions
4.7.2.6	Cesium Product Canister Failure Under Pressure (LAW only)	One cesium product canister with maximum loading - 6000 TBq ^{137}Cs	0.07	$ Enough water can be left in the canister to pressurize it to failure $ There is no common mode failure to involve more than one canister $ CST is modeled as a powder
4.7.2.7	HLW Melter Failure (HLW/LAW option)	Glass contents of HLW melter	Cesium and technetium released until the pool cools to below the volatilization temperature	$ Surface area of spilled glass is 48.75 ft^2 $ Evaporation rate of cesium and technetium is 80 mg/hr-ft^2 $ Mass fractions of radioactive cesium to total cesium typical value 0.25 $ All technetium is ^{99}Tc
4.7.2.8	Ammonia Tank Breach (Both options)	25,000 lb. anhydrous ammonia	Gaseous release, 100% becomes airborne and is respirable	$ Total inventory of the tank becomes airborne $ Release occurs over 10 minutes
4.7.2.9	Nitric Acid Spill (Both options)	5000 gallons 12.2M nitric acid	Peak release calculated by EPA air emissions equation	C Ambient temperature = 80EF C Dimensions of catch basin are 45 ft x 30 ft C Airflow over the pool surface is 1 m/s
4.7.2.10	Design Basis Earthquake (LAW only option)	Systems assumed at risk: $ 241-AP-106 to TWRS-P transfer line $ Two LAW receipt tanks $ Seven cesium product canisters $ Cesium ion exchange column	As assumed for the accident scenario addressing each system failure alone.	C All systems included in the analysis contain their maximum possible inventory C Cesium product tank is not full at the beginning of cesium ion exchange elution. C Physical assumptions consistent with those used for analyses presented in Sections 4.7.2.1 through 4.7.2.9.
4.7.2.10	Design Basis Earthquake (HLW/LAW option)	Systems assumed at risk: $ 241-AP-106 to TWRS-P transfer line $ Two LAW receipt tanks $ Three HLW receipt tanks $ Cesium/technetium product storage tank $ Cesium ion exchange column $ HLW melter	As assumed for the accident analysis addressing each system failure alone.	C All systems included in the analysis contain their maximum possible inventory C Neither the HLW ultrafilters nor the HLW melter feed tank are filled to maximum capacity simultaneously with all three HLW receipt tanks. C Physical assumptions consistent with those used for analyses presented in Sections 4.7.2.1 through 4.7.2.9.

4.7.2.1 LAW Receipt Tank Failure{tc \l4 "4.7.2.1 LAW Receipt Tank Failure}. The bounding liquid release scenario for the LAW only option postulates catastrophic failure of one of the feed receipt tanks. The bounding inventory involves a LAW receipt tank filled with Envelope B waste.

4.7.2.1.1 Scenario Development. LAW is transferred in batches from DST 241-AP-106 into receipt tanks V2101 and V2102. The capacity of each of the receipt tanks is 227 m^3 (60 kgal), and the design inventory is 200 m^3 (33 kgal) liquid and 1.5 m^3 (0.4 kgal) solids. Of the three LAW envelopes, Envelope B provides the highest combination of radionuclides that contribute significantly to radiological exposures.

Catastrophic failure of one of the tanks occurs while it is filled with its design inventory of Envelope B waste. The entire contents of the tank spill to the floor. For conservatism, no credit is taken for any engineered barriers that may contain the release, or reduce the proportion that leaves the facility.

4.7.2.1.2 Source Term Analysis{tc \l5 "4.7.2.1.2 Source Term Analysis}. The radionuclide content of the Envelope B waste is given in Specification 7 of the contract for LAW and HLW or LAW-Only treatment services between DOE-RL and BNFL Inc. (DOE-RL 1996). The contract values are given as the maximum ratio of the specified radionuclide to moles sodium. The waste feed is delivered with a sodium concentration between 3M and 14M. For the purpose of this analysis, the basis is 7M sodium. Table 4-35 presents the radionuclide concentrations in the Envelope B waste assuming the sodium content is 7M.

Table 4-35. Maximum Radionuclide Content of Envelope B Waste in the LAW Receipt Tank based on Contract Values and 7M Sodium Content

Radionuclide	Envelope B Activity (Bq/L)
Cs-137	4.20×10^{11}
Sr-90	3.99×10^{8}
Tc-99	4.97×10^{7}
Am-241	3.99×10^{6}
Pu-239	1.05×10^{5}
Pu-240	1.05×10^{5}

The unit liter dose (ULD) for the material is the dose to a receptor per liter inhaled. To obtain the ULD, the concentration for each radionuclide is multiplied by the published dose conversion factor for inhalation of that radionuclide. The inhalation dose conversion factors for the radionuclides of interest for the TWRS-P Facility accident analysis are presented in Table 4-26. The ULD for inhalation of the Envelope B waste is the sum of the ULDs of the individual radionuclides. The ULD for the Envelope B waste is presented in Table 4-36.

Table 4-36. Unit Liter Dose (ULD) for Envelope B Waste

Radionuclide	**CEDE (Sv/L)**
Cs-137	3.62×10^3
Sr-90	28.8
Tc-99	0.112
Am-241	479
Pu-239	12.2
Pu-240	12.2
Total	4.15×10^3

The spill involves two mechanisms for airborne release of respirable particles from the facility; the first from the suspension of droplets as a result of the free fall of the liquid from a height assumed to be less than 3 meters (the top of the tank or highest nozzle) the other from the resuspension of material in airflows over the spilled liquid. The latter is assumed to occur over a 24-hour period.

For the free fall mechanism, the ARF is 2×10^{-4} and the RF is 0.5. These are the bounding values given in Section 3.2.3.1 of DOE-HDBK-3010-94 (DOE 1994) for an aqueous solution with a density near 1, and a fall distance less than 3 m.

The tank breach would need to be near the bottom of the tank, considerably less than 3 m from the floor, for the full inventory of the tank to be involved in the spill. If the breach occurred higher up, the material at risk for the spill would be reduced proportionally. Therefore, assuming the bounding release fractions for a fall height of less than three, and involving the entire contents of the tank, is a conservative approach.

The source term from the proportion of the release that becomes airborne in the free fall, ST_{ff}, and is of respirable size is calculated by multiplying the volume of the spill (2×10^5 L), converted to its

$$ST_{ff} = 2.0 \times 10^5 \ L \times 4.15 \times 10^3 \frac{Sv}{L} \times 2.0 \times 10^{-4} \times 0.5$$
$$= 8.31 \times 10^4 \ Sv$$

inhalation dose equivalent, by the ARF x RF:
For the aerodynamic entrainment and resuspension in airflows passing over the spilled pool, the bounding airborne release rate (ARR) is 4×10^{-7} per hour (DOE 1994, Section 3.2.4.5). This value assumes the liquid spill is indoors on a heterogeneous surface exposed to forced building ventilation. For a 24- hour release, the ARF is then

$$ARF = ARR \times t$$
$$= \frac{4 \times 10^{-7}}{hr} \times 24\ hr$$
$$= 9.6 \times 10^{-6}$$

The RF for the resuspension in airflows is 1.0.

The source term from the proportion of the release that becomes airborne by aerodynamic resuspension from the spilled pool, ST_r, is calculated by multiplying the volume of the spill (2×10^5 L), converted to its inhalation dose equivalent, by the ARF x RF for the aerodynamic resuspension:

$$ST_r = 2.0 \times 10^5\ L \times 4.15 \times 10^3\ \frac{Sv}{L} \times 9.6 \times 10^{-6} \times 1.0$$
$$= 7.98 \times 10^3\ Sv$$

4.7.2.1.3 Consequence Analysis. For an unmitigated scenario, the release is assumed to be from ground level with no credit taken for hold-up in the building. The portion of the release suspended in the free fall is assumed to be released over a period of time considerably less than one hour. Therefore, the calculation of the receptor uptake for this part of the release uses the ×/Q without credit for building wake or plume meander and the short term breathing rate.

For the public receptor, 11.9 km southeast of the facility, the exposure from inhalation of the portion of the release attributed to the liquid free fall is:

$$CEDE_{ff} = 8.31 \times 10^4\ Sv \times 1.88 \times 10^{-5}\ \frac{s}{m^3} \times 3.47 \times 10^{-4}\ \frac{m^3}{s}$$
$$= 5.42 \times 10^{-4}\ Sv$$

Since the resuspension is assumed to take place over a 24-hour period, the ×/Q crediting building wake and plume meander was applied to this portion of the release. The short term breathing rate was applied for the first 8 hours of the release, and the long term breathing rate to the subsequent 16 hours.

For the public receptor, 11.9 km southeast of the facility, the exposure from inhalation of the portion of the release attributed to the aerodynamic entrainment and resuspension from the liquid pool is:

$$CEDE_r = \frac{7.98 \times 10^3}{3} Sv \times 1.5 \times 10^{-5}\ s\ over m^3 \times \left[3.47 \times 10^{-4} + (2 \times 1.75 \times 10^{-4}) \right] \frac{m^3}{s}$$
$$= 2.78 \times 10^{-5}\ Sv$$

The total exposure to the public receptor is the sum of the exposure from the two release mechanisms 5.70 x 10^{-4} Sv (0.057 rem).

The exposure to the co-located worker, if the release is assumed to be from ground level, is calculated similarly, only using the atmospheric dispersion coefficients for the maximum exposure 100 m from the release. For the aerodynamic entrainment portion of the release, however, the duration of exposure is taken to be only 8 hours, the length of one working shift.

$$CEDE_{ffw} = 8.31 \times 10^4\ Sv \times 3.41 \times 10^{-2} \frac{s}{m^3} \times 3.47 \times 10^{-4} \frac{m^3}{s}$$
$$= 0.98\ Sv$$

$$CEDE_{rw} = \frac{7.98 \times 10^3}{3} Sv \times 8.55 \times 10^{-3}\ s\ over m^3 \times 3.47 \times 10^{-4} \frac{m^3}{s}$$
$$= 7.89 \times 10^{-3}\ Sv$$

The total exposure to the co-located worker is the sum of the exposure from the two release mechanisms, 0.99 Sv (99 rem).

4.7.2.1.4 Comparison to Radiological Exposure Standards. The maximum potential exposure to the public receptor from a spill of the contents of a LAW receipt tank is 0.06 rem, well below the exposure standard of 5 rem to the public. Therefore, the engineered systems in place that would mitigate the release do not require Design Class I design. However, the exposure to the co-located worker 100 m from the facility is greater than the 25 rem standard. The potential exposure to facility workers also exceeds 25 rem. Therefore, mitigating features that protect the co-located worker and the facility worker are Design Class II.

4.7.2.1.5 Mitigating Design Features. The receipt tanks are in steel lined cells with filtered ventilation. Ventilation control ensures that cells where radioactive material is handled are kept at lower pressure than non-radioactive areas. Therefore, air leakage through cell penetrations would be into the cell. The cell ventilation is routed out of the facility through an 88 m high stack.

With the ventilation system operating, and the release from the spill carried out through the stack, atmospheric dispersion is significantly greater so that exposure to the public receptor and the co-located worker are proportionately reduced. If the release is elevated 88 m, the atmospheric dispersion coefficient for the public is 2.48 x 10^{-6} without building wake or plume meander effects, and 2.25 x 10^{-6} with plume meander and building wake. Therefore, exposure to the public receptor is reduced to 7.57 x 10^{-5} Sv, (0.008 rem). For the elevated release, the limiting location for the public is 11.1 km (6.7 mi) south of the facility.

The limiting location for the co-located worker for the elevated release without plume meander is 380 m west of the facility. For the elevated release with plume meander, the limiting location is 440 m west. The total consequence was calculated for both locations to determine which was limiting. At 380 m (1246 ft.) west, the atmospheric dispersion coefficient without plume meander and building wake is 1.24 x 10^{-5} s/m^3 and with plume meander and building wake it is 8.50 x 10^{-6} s/m^3. At 440 m (1443 ft) west, the atmospheric dispersion coefficient without plume meander and building wake is 1.17 x 10^{-5} s/m^3 and with plume meander and building wake it is 9.56 x 10^{-6} s/m^3.

The 380 m west location was found to be the limiting location of the co-located worker for the total stack release. The exposure to the receptor at this location is 3.65 x 10^{-4} Sv, or 0.036 rem. Therefore, if the release is mitigated through cell and building ventilation and elevated through the building stack, exposure to the co-located worker is reduced to less than the exposure standard.

If release through cell and building ventilation systems to the stack is the method chosen to mitigate the consequences of the LAW receipt tank breach, the features of the ventilation system that assure routing the release to the stack are Design Class II features.

4.7.2.2 HLW Receipt Tank Failure. The bounding liquid release scenario for the HLW/LAW combined option is a catastrophic failure of a HLW receipt tank. For the HLW/LAW combined option, the bounding inventory is the maximum tank working volume of Envelope D feed.

4.7.2.2.1 Scenario Development. Envelope D feed is received into the TWRS-P Facility in one of three Envelope D receipt vessels (V4101 A/B/C). These vessels have a maximum working volume of 225 m^3 (59.5 kgal). A catastrophic failure of one of these tanks is postulated. The entire contents of the tank spill to the floor. For conservatism, no credit is taken for any engineered barriers that may contain the release, or reduce the proportion that leaves the facility.

4.7.2.2.2 Source Term Analysis. Radionuclide inventories for Envelope D waste are given in the DOE-RL BNFL Inc. contract (DOE-RL 1996). However, an existing criticality prevention specification would prohibit the transfer of solutions with the plutonium concentration specified by the contract (Johnson 1997). Therefore, the bounding plutonium and americium values have been adjusted to be consistent with the assumption that the criticality prevention specification will hold. The radionuclides that contribute importantly to the dose for the Envelope D waste, with plutonium and americium values adjusted in accordance with (Johnson 1997), are presented in Table 4-37.

The inhalation dose conversion factors for the radionuclides of interest for the TWRS-P Facility accident analysis are presented in Table 4-26. The ULD for inhalation of the Envelope D inventory is the sum of the contribution from the individual radionuclides. The ULD for the Envelope D feed is presented in Table 4-38.

The material at risk for one HLW receipt tank is 225 m^3 (738 ft). The HLW feed to the receipt tank will be in the form of a slurry of the waste solids in the tank supernatant liquid. The waste will need pretreatment to meet the requirements for Envelope D waste defined by the contract specification. The composition of the waste streams from three tanks, as they will come to the HLW receipt tank, is described in the *Phase I High-Level Waste Pretreatment and Feed Staging Plan* (WHC 1996). The HLW streams will contain 8-12 weight percent suspended solids.

Table 4-37. Radionuclide Inventory of HLW Receipt Tank Contents

Radionuclide	Envelope D Concentration (Adjusted) Ci/L
^{137}Cs	3.0
^{134}Cs	6.8×10^{-3}
^{90}Sr	3.1
^{99}Tc	4.5×10^{-3}
^{60}Co	3.0×10^{-3}
^{154}Eu	0.016
^{155}Eu	0.009
^{239}Pu	7.6×10^{-4}
^{240}Pu	2.08×10^{-4}
^{241}Pu	5.52×10^{-3}
^{241}Am	3.44×10^{-2}
^{244}Cm	9.3×10^{-4}

Table 4-38. Radionuclide Inventory of HLW Receipt Tank Contents

Radionuclide	Envelope D Unit Liter Dose Sv/L
^{137}Cs	958
^{134}Cs	3.14
^{90}Sr	7420
^{99}Tc	0.375
^{60}Co	0.992
^{154}Eu	45.8
^{155}Eu	3.73
^{239}Pu	3260
^{240}Pu	893
^{241}Pu	455
^{241}Am	1.53×10^{5}
^{244}Cm	2300

Table 4-38. Radionuclide Inventory of HLW Receipt Tank Contents

Radionuclide	Envelope D Unit Liter Dose Sv/L
Total ULD	1.68×10^{5}

Information from characterization of the waste in tank 241-AZ-101 is contained in *Tank 241-AZ-101 Criticality Assessment Resulting from Pump Jet Mixing sludge Mixing Simulations* (PNNL 1997). The HLW stream with the highest activity from radionuclides that contribute significantly to dose is from that tank. Assuming a liquid density of 1.2 kg/L and a solids density of 1.84 kg/L, the calculated density of the slurry is 1.25 kg/L. About 80% of the sludge particles fall in the range <8 micrometers geometric diameter, or < ~10.8 micrometers aerodynamic equivalent diameter (AED).

The mechanisms for airborne release of respirable material from the facility were taken to be the same as those used for the LAW-Only option; formation of airborne droplets as a result of free fall of a liquid solution from less than 3 m height, and resuspension for 24 hours from the spilled pool in building airflows. Section 3.2.3.2 of DOE-HDBK-3010-94 (DOE 1994) gives bounding values for ARF and RF for free fall of slurries. The bounding ARF for the free fall of slurries from heights less than 3 m is 5×10^{-5}, and the RF is 0.8.

For the full inventory of the tank to be involved in the spill, the tank breach would need to be near the bottom of the tank, considerably less than 3 m from the floor. If the breach occurred higher up, the material at risk for the spill would be reduced proportionally. Therefore, assuming the bounding release fractions for a fall height of less than three meters, and involving the entire contents of the tank, is a conservative approach.

The source term from the proportion of the release that becomes airborne in the free fall and is of respirable size, ST_{ff}, is calculated by multiplying the ULD by the tank inventory and then multiplying by the ARF x RF for free fall of a liquid:

$$ST_{ff} = 1.68 \times 10^{5} \frac{Sv}{L} \times 2.25 \times 10^{5}\ L \times 5.0 \times 10^{-5} \times 0.8$$
$$= 1.51 \times 10^{6}\ Sv$$

For the 24 hour resuspension of material from the spilled pool the ARF x RF value for a 24 hour suspension from an aqueous pool in building airflows is 9.6×10^{-6}. This is the same value used for the LAW receipt tank spill.

The source term from the proportion of the release that becomes airborne by aerodynamic resuspension from the spilled pool, ST_r, is calculated by multiplying the ULD by the tank inventory and then multiplying by the ARF x RF for the aerodynamic resuspension:

$$ST_r = 1.68 \times 10^5 \frac{Sv}{L} \times 2.25 \times 10^5\ L \times 9.6 \times 10^{-6} \times 1.0$$
$$= 3.63 \times 10^5\ Sv$$

4.7.2.2.3 Consequence Analysis{tc \l5 "4.7.2.2.3 Consequence Analysis}. The portion of the release suspended in the free fall is assumed to be released over a period of time considerably less than one hour. Therefore, the calculation of the receptor uptake for this part of the release used the ×/Q without building wake or plume meander and the short term breathing rate.
For the public receptor, 11.9 km (7.4 mi.) southeast of the facility, the exposure from inhalation of the portion of the release attributed to the liquid free fall is:

$$CEDE_{ff} = 1.51 \times 10^6\ Sv \times 1.88 \times 10^{-5} \frac{s}{m^3} \times 3.47 \times 10^{-4} \frac{m^3}{s}$$
$$= 9.87 \times 10^{-3}\ Sv$$

Since the resuspension is assumed to take place over a 24-hour period, the ×/Q crediting building wake and plume meander was applied to this portion of the release. The short term breathing rate was applied for the first 8 hours of the release, and the long term breathing rate to the subsequent 16 hours.

For the public receptor, 11.9 km (7.4 mi.) southeast of the facility, the exposure from inhalation of the portion of the release attributed to the aerodynamic entrainment and resuspension from the liquid pool is:

$$CEDE_r = \frac{3.63 \times 10^5}{3}\ Sv \times 1.5 \times 10^{-5}\ s\,overm^3 \times \left[3.47 \times 10^{-4} + (2 \times 1.75 \times 10^{-4}) \right] \frac{m^3}{s}$$
$$= 1.26 \times 10^{-3}\ Sv$$

The total exposure to the public receptor is the sum of the exposure from the two release mechanisms, 0.011 Sv, (1.1 rem).

The exposure to the co-located worker, if the release is assumed to be from ground level, is calculated similarly, only using the atmospheric dispersion coefficients for the maximum exposure 100 m from the release. For the aerodynamic entrainment portion of the release, however, the duration of exposure is taken to be only 8 hours, the length of one working shift.

$$CEDE_{ffw} = 1.51 \times 10^6\ Sv \times 3.41 \times 10^{-2} \frac{s}{m^3} \times 3.47 \times 10^{-4} \frac{m^3}{s}$$
$$= 17.9\ Sv$$

$$CEDE_{rw} = \frac{3.63 \times 10^{5}}{3} Sv \times 8.55 \times 10^{-3} \frac{s}{m^{3}} \times 3.47 \times 10^{-4} \frac{m^{3}}{s}$$
$$= 0.36\ Sv$$

The total exposure to the co-located worker is the sum of the exposure from the two release mechanisms, 18.2 Sv or 1820 rem.

4.7.2.2.4 Comparison to Radiological Exposure Standards{tc \l5 "4.7.2.2.4 Comparison to Radiological Exposure Standards}. The maximum potential exposure to the public receptor from a spill of the contents of a HLW receipt tank is 1.1 rem, less than the exposure standard of 5 rem to the public. Therefore, the engineered systems in place that would mitigate the release do not require Design Class I design. However, the exposure to the co-located worker 100 m from the facility is greater than the 25 rem standard. The potential exposure to facility workers also exceeds 25 rem. Therefore, mitigating features that protect the co-located worker and the facility worker are Design Class II.

4.7.2.2.5 Mitigating Design Features. The receipt tanks are in steel lined cells with filtered ventilation. Ventilation control ensures that cells where radioactive material is handled are kept at lower pressure than non-radioactive areas. Therefore, air leakage through cell penetrations would be into the cell. The cell ventilation is routed out of the facility through an 88 m high stack.

With the ventilation system operating, and the release from the spill carried out through the stack, atmospheric dispersion is significantly greater so that exposure to the public receptor and the co-located worker are proportionately reduced. If the release is elevated 88 m, the atmospheric dispersion coefficient for the public is 2.48×10^{-6} without building wake or plume meander effects, and 2.25×10^{-6} with plume meander and building wake. Therefore, exposure to the public receptor is reduced to 1.49×10^{-3} Sv, or 0.15 rem. For the elevated release, the limiting location for the public is 11.1 km (6.9 mi) south of the facility.

The limiting location for the co-located worker for the elevated release without plume meander is 380 m west of the facility. For the elevated release with plume meander, the limiting location is 440 m west. The total consequence was calculated for both locations to determine which was limiting. At 380 m west, the atmospheric dispersion coefficient without plume meander and building wake is 1.24×10^{-5} s/m^3 and with plume meander and building wake it is 8.50×10^{-6} s/m^3. At 440 m west, the atmospheric dispersion coefficient without plume meander and building wake is 1.17×10^{-5} s/m^3 and with plume meander and building wake it is 9.56×10^{-6} s/m^3.

The 380 m west location was found to be the limiting location for the total stack release. The exposure to the receptor at this location is 6.9×10^{-3} Sv, or 0.69 rem. Therefore, if the release is mitigated through cell and building ventilation and elevated through the building stack, exposure to the co-located worker is reduced to less than the exposure standard.

If release through cell and building ventilation systems to the stack is the method chosen to mitigate the consequences of the HLW receipt tank breach, the features of the ventilation system that assure routing the release to the stack are Design Class II features.

4.7.2.3 Drop of a Cesium Product Canister. The bounding particulate release scenario for the LAW-Only option is a drop and breach of a cesium product canister.

4.7.2.3.1 Scenario Development. For the LAW only option, cesium eluted from the ion-exchange column is subsequently adsorbed onto another ion-exchange medium, CST. The CST column is constructed of seamless Schedule 40 stainless steel pipe 27.3 cm (10.75 in.) diameter and 113.6 cm (288.5 in.) in length.

CST is a nonregenerable inorganic powder (20 to 40 mesh size) that has a very high affinity for cesium in acidic or alkaline media. It was developed by Sandia National Laboratories and is manufactured by UOP Molecular Sieves.
Each column of CST can hold up to 6000 TBq (1.63 x 10^5 Ci) of cesium-137. The cesium-loaded CST is rinsed with demineralized water and then dried. The column is overpacked in a container of 32.3 cm (12.7 in.) Schedule 80 stainless steel pipe. A lid is welded onto the outer container and the container is leak tested. Overpacked containers are sent to 60-day storage and ultimately returned to DOE.

This scenario postulates that a cesium product canister is dropped during packaging. The dry powder spilled is an upper bound for other spills of the material. The spill is assumed to occur from a height of less than 3 m (9.8 ft.).

4.7.2.3.2 Source Term Analysis{tc \l5 "4.7.2.3.2 Source Term Analysis}. The bounding ARF for the free fall of powders is given in Section 4.4.3.1 of DOE-HDBK-3010-94 (DOE 1994) as 2 x 10^{-3} for fall distances less than 3 m. (9.8 ft.). The RF for this case is 0.3.

Modeling the CST as a powder introduces a high degree of conservatism to the calculation, because the CST, as delivered, is a crystalline material with a range of 20 to 40 mesh size. Any very small particulates associated with the material on delivery are removed by washing. The force of the fall is insufficient to cause significant fragmentation. In the absence of specific particle size distribution data for the CST, the conservative assumption that it behaves like a powder is used.

The conversion of the total cesium-137 available to its inhalation dose equivalent is:

$$ST = 6.03 \times 10^{15}\, Bq \times 8.63 \times 10^{-9} \frac{Sv}{Bq}$$
$$= 5.20 \times 10^{7}\, Sv$$

The amount of airborne respirable material released by the fall is calculated by multiplying the quantity of cesium involved by the ARF x RF.

$$ST = 5.20 \times 10^{7}\, Sv \times 0.002 \times 0.3$$
$$= 3.12 \times 10^{4}\, Sv$$

Because the short-lived daughter product of cesium-137 decay produces strong gamma radiation, the contribution to the total exposure from external exposure to the plume, submersion and groundshine, are also considered for the co-located worker at 100 m downwind of the release. The total exposure at 100 m from these two pathways was found to be insignificant with respect to the inhalation exposure. The effect is even less at the location of the public receptor, because of the distance from the release.

4.7.2.3.3 Consequence Analysis. Since this is a short term release, the quantity of cesium-137 potentially inhaled by the offsite receptor after transport downwind was calculated using the ×/Q for a ground level release without plume meander and building wake effects, and using the acute breathing rate.

$$CEDE = 3.12 \times 10^{4}\ Sv \times 1.88 \times 10^{-5}\ \frac{s}{m^{3}} \times 3.47 \times 10^{-4}\ \frac{m^{3}}{s}$$
$$= 2.04 \times 10^{-4}\ Sv$$
$$= 0.020\ rem$$

The quantity of cesium-137 potentially inhaled by the offsite receptor after transport downwind is: Maximum exposure to the co-located worker 100 m from the facility, from the ground level release

$$CEDE = 3.12 \times 10^{4}\ Sv \times 3.41 \times 10^{-2}\ \frac{s}{m^{3}} \times 3.47 \times 10^{-4}\ \frac{m^{3}}{s}$$
$$= 0.37\ Sv$$
$$= 37\ rem$$

is:

4.7.2.3.4 Comparison to Radiological Exposure Standards. The maximum potential exposure to the public receptor from a spill of the contents of a cesium product canister is 0.02 rem, less than the exposure standard of 5 rem to the public. Therefore, the engineered systems that mitigate the release do not require Design Class I design. However, the exposure to the co-located worker 100 m from the facility is greater than the 25 rem standard. The potential exposure to facility workers also exceeds 25 rem. Therefore, mitigating features that protect the co-located worker and the facility worker from the consequence of a cesium product canister drop are Design Class II.

4.7.2.3.5 Mitigating Design Features. The packaging and handling of the cesium product canisters take place by remote operations in steel lined cells with filtered ventilation. Ventilation control ensures that cells where radioactive material is handled are kept at lower pressure than non-radioactive areas. Therefore, air leakage through cell penetrations would be into the cell. The cell ventilation is routed out of the facility through an 88 m (288.6 ft.) high stack.

With the ventilation system operating, and the release from the spill carried out through the stack, atmospheric dispersion is significantly greater so that exposure to the public receptor and the co-located worker are proportionately reduced. If the release is elevated 88 m, the atmospheric dispersion coefficient for the public is 2.48 x 10^{-6} without building wake or plume meander effects. Therefore, exposure to the public receptor is reduced to 2.69 x 10^{-5} Sv, or 0.003 rem. For the elevated release, the limiting location for the public is 11.1 km south of the facility.

The limiting location for the co-located worker for the elevated release without plume meander is 380 m west of the facility. At 380 m west, the atmospheric dispersion coefficient without plume meander and building wake is 1.24 x 10^{-5} s/m^3. The exposure to the receptor at this location is 1.34 x 10^{-4} Sv, or 0.013 rem. Therefore, if the release is mitigated through cell and building ventilation and elevated through the building stack, exposure to the co-located worker is reduced to less than the exposure standard.

If release through cell and building ventilation systems to the stack is the method chosen to mitigate the consequences of drop and breach of a cesium product canister, the features of the ventilation system that assure routing the release to the stack are Design Class II features.

4.7.2.4 Boiling of Technetium/Cesium Product Storage Tank. In the HLW/LAW combined option, eluate from the cesium ion exchange column will be combined with that from technetium ion exchange and stored in tank V2710. This scenario postulates loss of cooling to the cesium/technetium product tank allowing the tank contents to boil, and subsequent entrainment of radionuclides into airflows.

4.7.2.4.1 Scenario Development. Tank V2710 is in the technetium ion-exchange cell. For the LAW/HLW combined option, the tank receives the concentrated eluate from both the technetium and cesium ion exchange columns. The solutions are retained in the tank pending transfer to the HLW concentrate tank to be mixed with dewatered Envelope D waste, and other concentrated waste removed from the LAW.

The maximum capacity of Tank V2710 is 56.2 m^3 and the operating volume is 45 m^3. The normal operating temperature is 50 EC. The solutions in Tank V2710 have high heat generating capability from their radionuclide concentrations. Therefore, cooling is provided to the tank to prevent boiling.

It is assumed that cooling to the tank is lost. The rise in tank temperature goes undetected long enough for the contents to reach their boiling temperature and the boiling to continue for an extended period of time. For the analysis, the tank was assumed to boil for 24 hours. The vapor released by the boiling contains entrained radionuclides.

Physical considerations indicate that the tank contents may reach their boiling temperature, but the predicted time required is on the order of several days. A conservative estimate of the minimum time to boiling assumes there is no heat transfer from the tank.

The maximum radionuclide content of the tank is 200,000 TBq (3.8 x 10^6 Ci) cesium-137 and 900 TBq (2.4 x 10^4 Ci) technetium-99 (BNFL 1997a). The decay heat of cesium-137 in equilibrium with its daughter ^{137m}Ba, is 4.72 x 10^{-3} W/Ci. Because the heat contributed by technetium-99 decay is insignificant with respect to the total decay heat, it is neglected in the calculation. Therefore the total heat output of the solution in the tank is 25.5 kW.

The density of the concentrate is 1250 kg/m^3. The mass of 56.2 m^3 of the concentrate is 70,250 kg. Assuming the tank solution to be 6M nitric acid, the specific heat of the concentrate is 2.94 kJ/kg EC (Perry and Chilton 1973). If the temperature before cooling is lost is 45 EC, the time for the solution to reach 100 EC is:

$$T = \frac{70250\,kg\ x\ 2.94\,\frac{kJ}{kg°C}\ x\,(100 - 45)\,°C}{25.5\,\frac{kJ}{s}}$$
$$= 4.45\ x\ 10^5\ s$$
$$= 5.2\ days$$

When heat loss to the surroundings are taken into account, but neglecting evaporative heat losses, the time to boiling is estimated to be 11.6 days. It is concluded that there is sufficient time to restore cooling to the tank before boiling occurs.

4.7.2.4.2 Source Term Analysis. To provide a measure of the importance of restoring cooling to the tank, the bounding consequence of tank boiling, should it occur, is estimated. The maximum radionuclide content of the tank is 200,000 TBq (3.8 x 10^6 Ci) cesium-137 and 900 TBq (2.4 x 10^4 Ci) technetium-99 (BNFL 1997a). Conversion to dose equivalent gives a total of 1.73 x 10^9 Sv (1.73 x 10" rem) for the tank.

The bounding ARF for entrainment of salts in vapors above boiling dilute solutions, given in Section 3.2.1.2 of (DOE 1994), is 2 x 10^{-3}. A conservative RF value is 1.0. The source term from the scenario is:

$$Source\,Term = MAR\ x\ ARF\ \ x\ RF$$
$$= 1.73\ x\ 10^9\ Sv\ x\ 2\ x\ 10^{-3}\ x\ 1.0$$
$$= 3.46\ x\ 10^6\ Sv$$

Because the short-lived daughter product of cesium-137 decay produces strong gamma radiation, the contribution to the total exposure from external exposure to the plume, submersion and groundshine, are also considered for the co-located worker at 100 m downwind of the release. The total exposure at 100 m from these two pathways was found to be insignificant with respect to the inhalation exposure. The effect is even less at the location of the public receptor, because of the distance from the release.

4.7.2.4.3 Consequence Analysis. This is a sustained release over a 24 hour period. Therefore, the ×/Q crediting plume meander and building wake effects was applied. The short term breathing rate was assumed for the first eight hours, with the long term breathing rate assumed for the 8 to 24 hour period.

The 50 year committed effective dose equivalent to the public receptor, 11.9 km (7.4 mi.) southeast of the facility, from loss of temperature control on the cesium product tank is:

$$CEDE_p = \frac{3.46 \ x \ 10^6}{3} Sv \ x \ 1.5 \ x \ 10^{-5} \frac{s}{m^3} \ x \left[3.47 \ x \ 10^{-4} + (2 \ x \ 1.75 \ x \ 10^{-4}) \right] \frac{m^3}{s}$$
$$= 1.20 \ x \ 10^{-2} \ Sv$$
$$= 1.20 \ rem$$

The exposure to the co-located worker, 100 m east of the facility, is:

$$CEDE_w = \frac{3.46 \ x \ 10^6}{3} Sv \ x \ 3.41 \ x \ 10^{-2} \frac{s}{m^3} \ x \ 3.47 \ x \ 10^{-4} \frac{m^3}{s}$$
$$= 13.6 \ Sv$$
$$= 1360 \ rem$$

4.7.2.4.4 Comparison to Radiological Exposure Standards. The maximum potential exposure to the public receptor from uncontrolled boiling of tank V2710 for 24 hours is 1.20 rem, less than the exposure standard of 5 rem to the public. Therefore, the engineered systems in place that would mitigate the release do not require Design Class I design. However, the exposure to the co-located worker 100 m from the facility is greater than the 25 rem standard. The potential exposure to facility workers also exceeds 25 rem.

4.7.2.4.5 Mitigating Design Features. The consequence assessment given in the previous section is for the bounding case of tank boiling. Because of the estimated time it would take for the tank to come to boiling, it is reasonable to expect that loss of cooling is detected and boiling is prevented by restoration of cooling to the tank. Therefore, engineered features that mitigate releases resulting from loss of cooling to tank V2710 are not Design Class II.

4.7.2.5 Cesium Ion-Exchange Column Exothermic Reaction. This scenario postulates a thermal excursion leading to overpressure and catastrophic failure of the cesium ion-exchange column. The bounding inventory is the quantity of radioactive cesium on the column at breakthrough.

4.7.2.5.1 Scenario Development. A loss of cooling water occurs when the ion exchange column is fully loaded with cesium. This results in a degradation reaction and thermal explosion as described in DOE-HDBK-3010-94, Section 7.3.6 (DOE 1994). A thermal explosion is defined as the result of an exothermic reaction that proceeds under conditions of confinement, with inadequate provisions for dissipating the heat of reaction. The radiolytic and chemical degradation of the ion exchange resin is an exothermic reaction that accelerates until the vessel fails due to overpressure.

Releases from the failed column are hot gases generated by the degradation reaction, and flashing spray from the liquid in the column. In cases of resin degradation leading to an exotherm, the initial source of the exotherm is highly localized. This localized area may dry out resin and heat it to above its autocatalytic ignition temperature. When the column fails, some of the resin may burn, releasing adsorbed cesium in the combustion gases.

The liquid in the column is released as a spray and some flashes to vapor. A flashing spray release is a significant mechanism for the release of radionuclides. The worst case in this scenario is for the exotherm to develop shortly after the initiation of the elution cycle.

4.7.2.5.2 Source Term Analysis. The mass and activity balance calculations for the TWRS-P Facility estimate that it will take 50 column volumes of Envelope A or C waste, or 20 column volumes of Envelope B waste to load a cesium ion-exchange column. One column volume is 1.048 m^3. The Envelope B case bounds the LAW. Based on the assumption of a 7M sodium solution, as developed in Section 4.7.2.1, the cesium-137 concentration of the Envelope B waste is 4.2 x 10^{11} Bq/L. Therefore, the estimated loading of radioactive cesium on the ion-exchange column is 8.8 x 10^{15} Bq (2.4 x 10^5 Ci).

It is assumed that the accident occurs at the beginning of the column elution cycle, when the cesium concentration in the liquid phase is at its highest. The total quantity of cesium in solution in the column was estimated from experimental data to be 1230 g (2.7 lb) (PNNL 1995). A typical ratio of cesium-137 to total cesium in Hanford tank wastes is 0.25 on a mass basis. Therefore, the estimated quantity of cesium-137 in the solution is 310 g (.7 lb). The specific activity of cesium-137 is 87 Ci/g. The total activity of the cesium-137 in solution is 9.9 x 10^{14} Bq (2.7 x 10^4 Ci).

The cesium-137 remaining on the resin is 7.8 x 10^{15} Bq (2.1 x 10^5 Ci).

The conversion of the cesium-137 on the resin to its inhalation dose equivalent is:

$$ST = 7.8 \ x \ 10^{15} \ Bq \ x \ 8.63 \ x \ 10^{-9} \ \frac{Sv}{Bq}$$
$$= 6.7 \ x \ 10^{7} \ Sv$$

The conversion of the cesium-137 in solution to its inhalation dose equivalent is:

$$ST = 9.9 \ x \ 10^{14} \ Bq \ x \ 8.63 \ x \ 10^{-9} \ \frac{Sv}{Bq}$$
$$= 8.6 \ x \ 10^{6} \ Sv$$

Calculation of the release that would occur as a result of a flashing spray release involves calculating the failure pressure of the column to estimate the fraction of liquid that would flash. The columns are in the elution cycle when the accident occurs; therefore, the release fractions are applied to the cesium concentration in the eluate.

The ARF for the flashing spray, calculated from the correlation in DOE-HDBK-3010-94, Section 7.3.6 (DOE 1994) is 0.11 and the RF is 0.3. The dose equivalent for respirable airborne release from the flashing spray is 2.7 x 10^5 Sv (2.7 x 10^7 rem).

The ARF for cesium release from the resin under thermal stress is 0.01 and the RF is 1.0, based on the development of the scenario presented in (DOE 1994), Section 7.3.6. So the equivalent inhalation dose from the material released from the resin is 6.7 x 10^5 Sv (6.7 x 10^7 rem). The total source term from the resin release and flashing spray is 9.5 x 10^5 Sv (9.5 x 10^7 rem).

Because the short-lived daughter product of cesium-137 decay produces strong gamma radiation, the contribution to the total exposure from external exposure to the plume, submersion and groundshine, are also considered for the co-located worker at 100 m downwind of the release. The total exposure at 100 m from these two pathways was found to be insignificant with respect to the inhalation exposure. The effect is even less at the location of the public receptor, because of the distance from the release.

4.7.2.5.3 Consequence Analysis. It is assumed that the duration of the release is less than one hour, because the material is expelled by pressurization of the column and flashing liquid. Therefore, the ×/Q value without plume meander and building wake effects, and the short term breathing rate, are applied. The 50-year committed effective dose equivalent to the estimated offsite receptor from an unmitigated fire and flashing liquid spray in the cesium ion-exchange column is:

$$\begin{aligned} CEDE &= 9.48 \ x \ 10^5 \ Sv \ x \ 1.88 \ x \ 10^{-5} \frac{s}{m^3} \ x \ 3.47 \ x \ 10^{-4} \frac{m^3}{s} \\ &= 6.2 \ x \ 10^{-3} \ Sv \\ &= 0.62 \ rem \end{aligned}$$

Maximum exposure to the co-located worker 100 m from the facility, from the ground level release is:

$$\begin{aligned} CEDE &= 9.48 \ x \ 10^5 \ Sv \ x \ 3.41 \ x \ 10^{-2} \frac{s}{m^3} \ x \ 3.47 \ x \ 10^{-4} \frac{m^3}{s} \\ &= 11.2 \ Sv \\ &= 1120 \ rem \end{aligned}$$

4.7.2.5.4 Comparison to Radiological Exposure Standards. The maximum potential exposure to the public receptor from an exothermic reaction in the ion exchange column, accompanied by a splashing liquid release, is .0062 Sr (0.62 rem), less than the exposure standard of 5 rem to the public. Therefore, the engineered systems that mitigate the release do not require Design Class I design. However, the exposure to the co-located worker 100 m from the facility is greater than the 25 rem standard. The potential exposure to facility workers also exceeds 25 rem. Therefore, mitigating features that protect the co-located worker and the facility worker from the consequences of the ion exchange column failure are Design Class II.

4.7.2.5.5 Mitigating Design Features. The cesium ion-exchange columns are in steel lined cells with filtered ventilation. Ventilation control ensures that cells where radioactive material is handled are kept at lower pressure than non-radioactive areas. Therefore, air leakage through cell penetrations would be into the cell. The cell ventilation is routed out of the facility through an 88 m high stack.
Atmospheric dispersion is significantly greater with the ventilation system operating, and the release from the spill carried out through the stack, so that exposure to the public receptor and the co-located worker are proportionately reduced. If the release is elevated 88 m, the atmospheric dispersion coefficient for the public is 2.48×10^{-6} without building wake or plume meander effects. Therefore, exposure to the public receptor is reduced to 8.2×10^{-4} Sv (0.082 rem). For the elevated release, the limiting location for the public is 11.1 km (6.9 mi) south of the facility.

The limiting location for the co-located worker for the elevated release without plume meander is 380 m west of the facility. At 380 m west, the atmospheric dispersion coefficient without plume meander and building wake is 1.24×10^{-5} s/m^3. The exposure to the receptor at this location is 4.1×10^{-3} Sv (0.41 rem). Therefore, if the release is mitigated through cell and building ventilation and elevated through the building stack, exposure to the co-located worker is reduced to less than the exposure standard.

If release through cell and building ventilation systems to the stack is the method chosen to mitigate the consequences of the cesium ion-exchange column fire, the features of the ventilation system that assure routing the release to the stack are Design Class II features.

4.7.2.6 Cesium Product Canister Pressurized Release. Breach of a cesium product canister because of internal pressurization, and dispersion of the contents during relief of the overpressure, is the bounding pressurized release scenario for the LAW-Only option.

4.7.2.6.1 Scenario Development{tc \l5 "4.7.2.6.1 Scenario Development}. The solution resulting from concentration by evaporation of the eluate from the cesium ion-exchange column is neutralized and loaded onto an inorganic ion-exchange medium, CST, in canisters. After the cesium is transferred, the CST bed is washed with demineralized water and then dried using its own heat generation and a slow circulating air feed. The canisters are packaged in containers made of 12 in. Schedule 80 pipe for storage before returning the product to the DOE.

This scenario assumes that the CST is a powder, and that the drying of the bed has been ineffective. During storage, gases generated from vaporization and radiolytic breakdown of the residual water pressurize the container until it fails, ejecting the cesium-137 powder.

4.7.2.6.2 Source Term Development. The maximum cesium-137 content of a CST container is 6.03×10^{15} Bq. The conversion of the total available cesium-137 to its inhalation dose equivalent is:

$$ST = 6.03 \times 10^{15}\, Bq \times 8.63 \times 10^{-9} \frac{Sv}{Bq}$$
$$= 5.20 \times 10^{7}\, Sv$$

The ARF and RF for this event were assumed to be those given for sudden venting of gases between pressure differentials greater than 0.17 MPa through a bed of powder. This is consistent with the recommendation given in Section 4.4.2.3.1 of DOE-HDBK-3010-94 (DOE 1994). The bounding ARF is given as 0.1, with a bounding RF of 0.7.
Modeling the CST as a powder introduces a high degree of conservatism to the calculation, because the CST, as delivered, is a crystalline material with a range of 20 to 40 mesh size. Any very small particulates associated with the material on delivery are removed by washing. The force associated with the release is insufficient to cause significant fragmentation. In the absence of specific particle size distribution data for the CST, the conservative assumption that it behaves like a powder is used.

The amount of airborne respirable material released by the pressurized release is calculated by multiplying the quantity of cesium involved by the ARF x RF.

$$ST = 5.20 \times 10^{7}\, Sv \times 0.1 \times 0.7$$
$$= 3.64 \times 10^{6}\, Sv$$

Because the short-lived daughter product of cesium-137 decay produces strong gamma radiation, the contribution to the total exposure from external exposure to the plume, submersion and groundshine, are also considered for the co-located worker at 100 m downwind of the release. The total exposure at 100 m from these two pathways was found to be insignificant with respect to the inhalation exposure. The effect is even less at the location of the public receptor, because of the distance from the release.

4.7.2.6.3 Consequence Analysis. Since this is a short-term release, the quantity of cesium-137 potentially inhaled by the offsite receptor after transport downwind was calculated using the ×/Q for a ground level release without plume meander and building wake effects, and using the short term breathing rate.

The quantity of cesium-137 potentially inhaled by the offsite receptor after transport downwind is:

$$CEDE = 3.64 \times 10^{6}\, Sv \times 1.88 \times 10^{-5} \frac{s}{m^3} \times 3.47 \times 10^{-4} \frac{m^3}{s}$$
$$= 0.024\, Sv$$
$$= 2.4\, rem$$

Maximum exposure to the co-located worker 100 m from the facility, from the ground level release is:

$$CEDE = 3.64 \; x \; 10^{6} \; Sv \; x \; 3.41 \; x \; 10^{-2} \; \frac{s}{m^{3}} \; x \; 3.47 \; x \; 10^{-4} \; \frac{m^{3}}{s}$$
$$= 43.1 \; Sv$$
$$= 4310 \; rem$$

4.7.2.6.4 Comparison to Radiological Exposure Standards. The maximum potential exposure to the public receptor from a pressurized release of the contents of a cesium product canister is .024 Sv (2.4 rem), less than the exposure standard of 5 rem to the public. Therefore, the engineered systems that mitigate the release do not require Design Class I design. However, the exposure to the co-located worker 100 m from the facility is greater than the 25 rem standard. The potential exposure to facility workers also exceeds 25 rem. Therefore, mitigating features that protect the co-located worker and the facility worker from the consequences of a pressurized release from a cesium product canister are Design Class II.

4.7.2.6.5 Mitigating Design Features. The cesium product canisters are stored, pending return to DOE, in steel lined cells with filtered ventilation. Ventilation control ensures that cells where radioactive material is handled are kept at lower pressure than non-radioactive areas. Therefore, air leakage through cell penetrations would be into the cell. The cell ventilation is routed out of the facility through an 88 m high stack.

With the ventilation system operating, and the release carried out through the stack, atmospheric dispersion is significantly greater so that exposure to the public receptor and the co-located worker are proportionately reduced. If the release is elevated 88 m, the atmospheric dispersion coefficient for the public is 2.48 x 10^{-6} without building wake or plume meander effects. Therefore, exposure to the public receptor is reduced to 3.14 x 10^{-3} Sv (0.31 rem). For the elevated release, the limiting location for the public is 11.1 km south of the facility.

The limiting location for the co-located worker for the elevated release without plume meander is 380 m west of the facility. At 380 m west, the atmospheric dispersion coefficient without plume meander and building wake is 1.24 x 10^{-5} s/m^3. The exposure to the receptor at this location is 1.6 x 10^{-2} Sv (1.6 rem). Therefore, if the release is mitigated through cell and building ventilation and elevated through the building stack, exposure to the co-located worker is reduced to less than the exposure standard.

If release through cell and building ventilation systems to the stack is the method chosen to mitigate the consequences of the cesium product canister breach due to overpressure, the features of the ventilation system that assure routing the release to the stack are Design Class II features.

4.7.2.7 Molten Glass Spill Scenario. The consequence of a spill of the molten glass contents of the HLW melter during melter operation bounds the glass spill scenarios.

4.7.2.7.1 Scenario Development. This scenario postulates a failure of the HLW melter such that molten glass spills to the cell floor. The volume of glass in a full melter is 5.6 m^3. The area covered by the glass spill is the floor of the HLW melter cell, 6.5 m by 7.5 m, or 48.75 m^2. The glass temperature is 1150 EC, and the cell temperature is 38 EC at the initiation of the accident.

Volatile and semivolatile radionuclides will be released from the molten glass pool into the air. The only semivolatile species that contribute significantly to the release are cesium-134, cesium-137 and technetium-99. Strontium and the transuranic species are nonvolatile, and therefore do not contribute significantly to the release.

4.7.2.7.2 Source Term Analysis. The calculation of radionuclides released from the spilled material follows the derivation found in *Maximum Cesium Release Assessment for Defense Waste Processing Facility Operations* (Randall and Yau 1987). The derivation relates the evaporation rate of cesium to the temperature of the pool as it cools by radiative heat transfer. The cesium evaporation rate, 80 mg/hr-ft^2 at 1150 EC, is based on an estimate from data collected from the Liquid Slurry Fed Melter (LSFM) at the Savannah River Site.

The total cesium release from the spill was predicted to be 2230 mg. This would be the total cesium, radioactive and non-radioactive in the melter material. A typical value for the ratio of cesium-137 to total Cs in tank forms waste is 0.25.

The released radioactive cesium is then 560 mg cesium-137 with activity of 48.5 Ci (1.8 x 10^{12} Bq). No data are available for the release of technetium, so it is conservatively assumed that the technetium will be released at the same rate as the cesium; i.e., that is 2230 mg of technetium is also released, and that it is all radioactive technetium. Based on that assumption, and the specific activity of technetium-99 being 0.017 Ci/g, 1.4 x 10^9 Bq of technetium-99 is released.

The conversion of the volatile radionuclides released to their inhalation dose equivalents are given in the following equations:

$$ST_{Cs137}\ 1.8\ x\, 10^{12}\ Bq\ x\ 8.63\ x\, 10^{-9}\ \frac{Sv}{Bq}$$
$$= 1.5\ x\, 10^{4}\ Sv$$
$$= 1.5\ x\, 10^{6}\ rem$$

$$ST_{Tc99} = 1.40\ x\, 10^{9}\ Bq\ x\ 2.25\ x\, 10^{-9}\ \frac{Sv}{Bq}$$
$$= 3.15\ Sv$$
$$= 315\ rem$$

The total equivalent dose for the material released is 1.5 x 10^4 Sv 1.5 x 10^6 rem.

4.7.2.7.3 Consequence Analysis. The ×/Q used credits building wake effects and plume meander because the release of the radionuclides to the air is a sustained process as the molten pool cools. It is expected that the pool will cool to below the volatilization temperatures of the radionuclides in less than 8 hours. Therefore, the acute breathing rate is applied for both the public receptor and the co-located worker. The ÷/Q at 11.9 km southeast for ground level releases crediting building wake effects and plume meander is 1.5 x 10^{-5} s/m^3.

The potential exposure to the public receptor from the spill of the HLW melter contents is:

$$
\begin{aligned}
CEDE &= 1.5 \times 10^{4}\ Sv \times 1.50 \times 10^{-5}\ \frac{s}{m^3} \times 3.47 \times 10^{-4}\ \frac{m^3}{s} \\
&= 8.1 \times 10^{-5}\ Sv \\
&= 0.008\ rem
\end{aligned}
$$

Maximum exposure to the co-located worker 100 m from the facility, from the ground level release is:

$$CEDE = 1.5 \times 10^4 \ Sv \times 8.55 \times 10^{-3} \frac{s}{m^3} \times 3.47 \times 10^{-4} \frac{m^3}{s}$$
$$= 0.046 \ Sv$$
$$= 4.6 \ rem$$

4.7.2.7.4 Comparison to Radiological Exposure Standards{tc \l5 "4.7.2.7.4 Comparison to Radiological Exposure Standards}. The maximum potential exposure to the public receptor from a spill of the HLW melter contents is 0.006 rem, less than the exposure standard of 5 rem to the public. The exposure to the co-located worker 100 m from the facility is also less than the 25 rem standard.

The potential exposure to facility workers has not been quantified, but is likely to exceed 25 rem. In this instance, neither Design Class I nor Design Class II mitigating features are required for the protection of either the public or the co-located worker. Design Class II mitigating features may be required for the protection of the facility worker.

4.7.2.7.5 Mitigating Design Features{tc \l5 "4.7.2.7.5 Mitigating Design Features}. No mitigating design features are required for protection of the public or co-located worker from the consequences of a release of volatile radionuclides from the spill of molten glass.

If the release is unmitigated, exposure to the facility worker would include effects from direct radiation shine, as well as inhalation and submersion pathways. Therefore, the melters are in shielded cells, and cell ventilation is designed to ensure that the cell atmosphere is routed to the stack, rather than allowing leakage into occupied areas of the building. The cell shielding and ventilation system may be Design Class II for protection of the facility worker.

4.7.2.8 Toxic Chemical Release - Breach of Ammonia Storage Tank{tc \l4 "4.7.2.8 Toxic Chemical Release - Breach of Ammonia Storage Tank}. The bounding scenario for release of ammonia is a breach of the ammonia storage tank.

4.7.2.8.1 Scenario Development{tc \l5 "4.7.2.8.1 Scenario Development}. The SCR unit uses ammonia to convert NO_x in the offgas from the LAW melters to nitrogen and steam. Anhydrous ammonia is supplied to the unit from a storage tank in the wet chemical storage area. The ammonia in the tank is under pressure sufficient to maintain it in the liquid state. The vapor pressure of ammonia at ambient temperatures is between 5 and 10 atmospheres. Therefore, the pressure in the tank will be maintained to 10 atmospheres absolute or greater.

A failure of the pressure boundary in the tank or the delivery system to the SCR would result in the release of ammonia vapor to the surroundings. The chemical storage area is outside the process building. It has a roof, but no walls. Therefore, a release of ammonia from the tank will travel downwind and may expose receptors to toxic concentrations of the chemical.

The U.S. Environmental Protection Agency (EPA) RMP regulations, 40 CFR 68, AChemical Accident Prevention Provisions,@ stipulate that a worst case scenario for release of materials that are vapor at ambient temperatures and handled as a liquid under pressure assume release of the full inventory over a period of 10 minutes. Although this analysis is not performed expressly for the purpose of compliance with that rule, those conditions are assumed for this scenario.

The *Model Risk Management Program and Plan for Ammonia Refrigeration* (SAIC 1996) presents the rationale to show that these are reasonable assumptions for a bounding scenario. That analysis also concluded, that all the ammonia becomes and remains airborne; i.e., there is no significant reduction of transported material because of fall-out of liquid droplets as the cloud travels downwind.

4.7.2.8.2 Source Term Development. The capacity of the ammonia storage tank is 25,000 lb (1.14×10^4 kg) liquefied anhydrous ammonia. As stated above, it is assumed that the entire inventory is released over a 10-minute period. Therefore the release rate is 2,500 lb/min.

4.7.2.8.3 Consequence Analysis. For the toxic releases from accidents, the consequence analysis uses the data recommended by the EPA in *RMP Offsite Consequence Analysis Guidance* (EPA 1996). The reference provides tables for determining the minimum distance from the release where the airborne concentrations of the released material are lower than the exposure limit, called the toxic endpoint by the guidance document, for that material.

Ammonia is treated as a neutrally buoyant gas. Therefore distance to the toxic endpoint is taken from Reference Table B-1 of the EPA guidance. The data on that table assume a 10 minute release, rural conditions, F atmospheric stability class and 1.5 m/s wind speed.

To use the table, the release rate in pounds per minute is divided by the toxic endpoint in mg/L. The toxic endpoint for ammonia is the ERPG-2 limit 0.138 mg/L, (200 ppm). The release rate divided by the toxic endpoint gives a value of 18,000. The distance to the toxic endpoint given by the reference for a value of 18,000 is 5 miles (8.0 km).

4.7.2.8.4 Comparison to Exposure Standards. The estimated air concentration of ammonia is lower than the 200 ppm exposure standard at all locations greater than 8.0 km (5.0 mi) from the release. The nearest location of a public receptor is 9.5 km (5.9 mi) south southwest of the TWRS-P Facility. The consequence of the release from the ammonia tank does not exceed the exposure standard for the offsite receptor. Therefore, no Design Class I features to mitigate or prevent the release are required.

The exposure to the co-located worker exceeds the ERPG-2 limit. Therefore, systems and controls to prevent or mitigate the release are Design Class II.

4.7.2.8.5 Mitigating Design Features. The ammonia tank is outside the pretreatment facility, which allows vaporized ammonia from the leak to freely travel with airflows. Therefore, design features to prevent the spill are preferred. Design of the tank to withstand the corrosive effect of its contents and the environmental conditions, protection of the tank and its connections from external forces, such as wind driven missiles or moving vehicles, and design to withstand seismic forces are necessary for protection of the co-located and facility worker.

4.7.2.9 Nitric Acid Spill. Nitric acid, in various strengths, is used in several areas of the TWRS-P Facility. The solutions are made up from 12.2M nitric acid, stored in a 18,900 L (5000 gal) tank in the cold chemical storage area outside the pretreatment building. A spill of nitric acid, caused by leakage of lines during filling or delivery to the facility, or by a catastrophic failure of the tank, could result in inhalation of toxic fumes and vapors by workers or the public.

4.7.2.9.1 Scenario Development{tc \l5 "4.7.2.9.1 Scenario Development}. The bounding spill is that resulting from catastrophic failure of the tank resulting in release to the ground of the full 18,900 L (500 gal) inventory. A catch basin capable of containing the full contents of the tank is provided under the tank. Following the spill, nitric acid vapors are entrained in the air by vaporization from the pool=s surface.

4.7.2.9.2 Source Term Analysis. Release of vapors from the surface of the spilled nitric acid is calculated using an equation from *Hazardous Waste Treatment, Storage and Disposal Facilities (TSDF) Air Emission Models* (EPA 1987) for the emission rate from pool surfaces:

$$E_i = \frac{2\, P_0\, MW_i\, Y_i\, L}{R\,T} \sqrt{\frac{D_i\, W\, U}{p\, F_v}}$$

Where:

Where:	E_i	=	emission rate of constituent i from the surface, g/s
	P_0	=	atmospheric pressure, mm Hg
	MW_i	=	molecular weight of constituent i, g/mol
	Y_i	=	equilibrium mole fraction of constituent i in the vapor phase (equal to partial pressure of i)
	L	=	dimension of spill area perpendicular to the direction of airflow, cm
	R	=	universal gas constant, 62,300 mm Hg cm^3/mol K
	T	=	temperature, K
	D_i	=	diffusion coefficient of constituent i in air, cm^2/s
	W	=	dimension of spill area parallel to airflow, cm
	U	=	velocity of air over the spill, cm/sec
	F_v	=	Fick=s Law correction factor.

The solution is initially 57% nitric acid by weight. Nitric acid vapor is the constituent of interest emitting from the pool surface. It is assumed that the ambient temperature is 27EC (80EF). Vapor pressures for water and nitric acid as a function of temperature and concentration were taken from (Perry and Chilton 1973). The nitric acid vapor pressure for 57% nitric acid at 27EC is 1.02 mm Hg.

Initially water evaporates from the pool at a greater rate than nitric acid, causing the pool to become more concentrated. The release rate of nitric acid from the surface increases until the vapor pressures of nitric acid and water are equal. This occurs at a concentration of 71.6% nitric acid and this mixture is called the azeotropic mixture. The nitric acid vapor pressure is 5.82 mm Hg at the azeotrope. At that concentration, the emission rate reaches a maximum and remains constant thereafter. The maximum emission rate from the pool is assumed for the bounding case. The following values for the above parameters were used in the calculation:

P0	=	760 mm Hg
MW_i	=	63 g/mol
Y_i	=	vapor pressure of nitric acid/total pressure; 7.66×10^{-3}
L	=	1372 cm (45 feet assumed)
R	=	62,300 mm Hg cm^3/mol K
T	=	300 K
D_i	=	0.118 cm^2/s
W	=	914 cm (30 feet assumed)
U	=	100 cm/sec (assumed)
F_v	=	0.9847 (EPA 1987).

For the azeotropic mixture the emission rate of nitric acid from the pool is 3.18 g/s.

4.7.2.9.3 Consequence Analysis. For the toxic releases from accidents, the consequence analysis uses the data recommended by the EPA in *RMP Offsite Consequence Analysis Guidance* (EPA 1996). The reference provides tables for determining the minimum distance from the release where the airborne concentrations of the released material are lower than the exposure limit, called the toxic endpoint by the guidance document, for that material.

Exhibit B-2 of the guidance document provides data to recommend assumptions for the treatment of toxic liquid releases. That table indicates that for a worst case scenario the evaporated nitric acid should be treated as a dense gas. Therefore the data from Reference Table 6 for a 60 minute release, rural conditions, F atmospheric stability class, and 1.5 m/s wind speed are used to estimate the distance to the toxic endpoint.

The release rate is 3.18 g/s (0.42 lb/min). ERPG limits for nitric acid have not been established by the AIHA. The DOE Subcommittee on Consequence Assessment and Protective Action (SCAPA) has adopted Temporary Emergency Exposure Limits (TEELs) for chemicals for which official ERPGs have not yet been developed (Craig 1997). The TEEL-2 for nitric acid is 15 ppm (38.6 mg/m^3).

Reference Table 6 gives a distance (1,056 ft) 320 m to the toxic endpoint for the nitric acid spill.

4.7.2.9.4 Comparison to Exposure Standards. The distance to the toxic endpoint for the nitric acid spill is well within the site boundary in all directions. Therefore, maximum exposure to the public is less than the exposure limit.

The distance to the toxic endpoint is greater than 100 meters. Therefore, exposure to the co-located worker and to facility workers exceeds the exposure standard. Therefore features to prevent or mitigate the effects of the nitric acid spill are Design Class II.

4.7.2.9.5 Mitigating Design Features. The nitric acid tank is outside the pretreatment facility, in the cold chemical storage area. This area has a roof, but no walls. Therefore, airborne vapors from the spill will freely travel with airflows. Therefore, design features to prevent the spill are preferred. Design of the tank to withstand the corrosive effect of its contents and the environmental conditions, protection of the tank and connections from external forces such as wind driven missiles and vehicles, and design to withstand seismic forces may be necessary for protection of the worker.

4.7.2.10 Design Basis Earthquake. An earthquake could result in simultaneous failures of multiple systems in the TWRS-P Facility.

4.7.2.10.1 Scenario Development. An earthquake occurs that causes catastrophic failure of systems and vessels relied upon to assure confinement of radioactive and toxic materials. For unmitigated analysis, it is assumed that the systems are not designed to withstand the forces of the earthquake.

The potential system failures considered for the DBE are different for the LAW-Only option and the HLW/LAW combined option. The source term and consequence analyses are, therefore, treated separately for each option.

4.7.2.10.2 Source Term Analysis. For the LAW only option, the systems assumed to fail and release significant radionuclide inventory are:

1) The transfer line between tank 241-AP-106 and the TWRS-P facility. The basis for assumed release inventory is that Envelope B waste is being transferred at a rate of 50 gpm, and the pump continues to run for 12.5 hours after the break occurs (Hall 1996a).

2) LAW receipt tanks, V2101 and V2102, containing their operating capacity (200 m^3) Envelope B waste. To be consistent with the transfer line break, it must be assumed that the earthquake occurs near the end of transfer to one of the receipt tanks, with the other receipt tank already full.

3) Seven cesium product canisters that have been loaded and are in-cell. The bounding inventory is assumed to be seven canisters, each with the maximum cesium-137 loading of 6.0×10^{15} Bq.

4) One cesium ion exchange column just beginning the elution cycle.

Table 4-39 summarizes the failures that are assumed to bound the radionuclide release for the LAW only option.

Table 4-39. System Failures to Bound Design Basis Earthquake Radionuclide Releases for the LAW Only Option

System	Failure Mode	Bounding Release Quantity	Dose Equivalent (rem)
Transfer line between 241-AP-106 and the TWRS-P Facility	Guillotine Break	140 m^3 Envelope B waste to the soil	5.0×10^6
Two LAW receipt tanks (V2101 and V2102)	Failure and spill of entire contents	400 m^3 Envelope B waste	1.8×10^7
Seven cesium product canisters	Fall and spill of contents	4.2×10^{15} Bq ^{137}Cs	2.2×10^7
Cesium ion exchange column	Loss of cooling, column failure, flashing spray release	One fully loaded Cs ion exchange column, Envelope B loading; 8.7×10^{13} Bq ^{137}Cs divided between resin and eluate	9.5×10^7
Total			1.4×10^8

For the HLW/LAW combined option, the systems assumed to fail and release significant radionuclide inventory are:

1) The transfer line between tank 241-AP-106 and the TWRS-P facility. The basis for assumed release inventory is that Envelope B waste is being transferred at a rate of 50 gpm, and the pump continues to run for 12.5 hours after the break occurs (Hall 1996a).

2) LAW receipt tanks, V2101 and V2102, containing their operating capacity (200 m^3) Envelope B waste. To be consistent with the transfer line break, it must be assumed that the earthquake occurs near the end of transfer to one of the receipt tanks, with the other receipt tank already full.

3) HLW receipt tanks, V4401 A, B, and C, each filled to its operating capacity (225 m^3) with Envelope D waste.

4) Technetium/cesium product storage tank, V2710, filled to design capacity (56.2 m^3) with concentrated cesium and technetium ion exchange eluate pending transfer to be blended with HLW melter feed.

5) One cesium ion exchange column just beginning the elution cycle.

6) The HLW melter at operating temperature and full inventory (5.6 m^3) of molten glass.

Table 4-40 summarizes the failures that are assumed to bound the release for the HLW/LAW combined option.

Table 4-40. System Failures to Bound Design Basis Earthquake Radionuclide Releases for the HLW/LAW Option

System	Failure Mode	Bounding Release Quantity	Dose Equivalent (rem)
Transfer line between 241-AP-106 and the TWRS-P Facility	Guillotine break	140 m^3 Envelope B waste to the soil	5.0×10^6
Two LAW receipt tanks (V2101 and V2102)	Failure and spill of entire contents	400 m^3 Envelope B waste	1.8×10^7
Three HLW receipt tanks (V4101 A, B, and C)	Failure and spill of entire contents	675 m^3 Envelope D waste	5.6×10^8
Cs/Tc product storage tank (V2710)	Failure and spill of entire contents	56.2 m^3 Cs and Tc ion exchange eluate	1.3×10^7
Cesium ion exchange column	Loss of cooling, column failure, flashing spray release	One fully loaded Cs ion exchange column, Envelope B loading; 8.7×10^{13} Bq ^{137}Cs divided between resin and eluate.	9.5×10^7
HLW melter	Failure and spill of molten glass contents	5.6 m^3 molten HLW glass product	1.5×10^6
Total			6.9×10^8

The bounding toxic releases for both options are the same as described in sections 4.7.2.8 and 4.7.2.9. Catastrophic failure and release of the entire contents of both the ammonia tank and the nitric acid tank in the cold chemical storage area are assumed. The release rate for the ammonia is 2,500 lb/min. Vaporization from the nitric acid pool gives a release rate of 3.18 g/s.

4.7.2.10.3 Consequence Analysis. The total source term from the assumed combined releases is multiplied by the atmospheric dispersion coefficient for ground level releases with no credit taken for building wake or plume meander. The maximum potential exposure to the public receptor from the releases following the DBE for the LAW only option is:

$$CEDE = 1.4\ x\ 10^{6}\ Sv\ x\ 1.88\ x\ 10^{-5}\ \frac{s}{m^{3}}\ x\ 3.47\ x\ 10^{-4}\ \frac{m^{3}}{s}$$
$$= 0.009\ Sv$$
$$= 0.9\ rem$$

Maximum exposure to the co-located worker 100 m from the facility, from the ground level

$$CEDE = 1.4\ x\ 10^{6}\ Sv\ x\ 3.41\ x\ 10^{-2}\ \frac{s}{m^{3}}\ x\ 3.47\ x\ 10^{-4}\ \frac{m^{3}}{s}$$
$$= 16.5\ Sv$$
$$= 1650\ rem$$

radionuclide release, following the DBE for the LAW-Only option is:
For the HLW/LAW combined option, the maximum potential exposure to the public receptor from

$$CEDE = 6.9\ x\ 10^{6}\ Sv\ x\ 1.88\ x\ 10^{-5}\ \frac{s}{m^{3}}\ x\ 3.47\ x\ 10^{-4}\ \frac{m^{3}}{s}$$
$$= 0.045\ Sv$$
$$= 4.5\ rem$$

the releases following the DBE is:
Maximum exposure to the co-located worker 100 m from the facility, from the ground level

$$CEDE = 6.9\ x\ 10^{6}\ Sv\ x\ 3.41\ x\ 10^{-2}\ \frac{s}{m^{3}}\ x\ 3.47\ x\ 10^{-4}\ \frac{m^{3}}{s}$$
$$= 82\ Sv$$
$$= 8200\ rem$$

radionuclide release, following the DBE for the HLW/LAW option is:
Maximum exposures from the ammonia releases for both options exceed exposure limits to the co-located worker. Maximum exposures from the nitric acid spill for both options also exceed exposure limits to the co-located worker.

4.7.2.10.4 Comparison to Exposure Standards. Maximum public exposures from failures related to a DBE for either the LAW-Only option or the HLW/LAW combined option do not exceed the radiological exposure standard of 5 rem. However, the public exposure for the HLW/LAW combined option is very close to the exposure standard. No Design Class I systems are required for mitigation of releases from the DBE for the LAW-Only option. For the HLW/LAW combined option, Design Class I systems for prevention or mitigation of the radiological releases may need consideration. Toxic exposure standards to the public are not exceeded for either option.

The radiological exposure standard of 25 rem to the co-located worker is exceeded for both options. And the releases from the ammonia tank and the nitric acid tank exceed the toxic exposure standards at the location of the co-located worker. Therefore, features that prevent or mitigate the releases from the DBE are Design Class II.

4.7.2.10.5 Mitigating Design Features. To prevent or mitigate the release from the DBE requires selection of a combination of systems designed to withstand the seismic forces. For the radiological releases, all the systems assumed by the analysis to fail are in-cell. Therefore, if the cell structure, ventilation systems and stack are designed to continue to perform their function of routing the release to the elevated release point during and after the DBE, the exposure to the co-located worker would be adequately mitigated.
As an alternative, the vessels containing major inventories of radioactive materials would be designed to retain their confinement function during and following the earthquake. For the HLW/LAW combined option, if the HLW receipt tanks are designed to resist the DBE forces, the public exposure is reduced to 0.7 rem. For both the LAW only option and the HLW/LAW combined option, all the systems included as contributors to the overall source term would be Design Class II for maintaining confinement of their contents during and following a DBE.

For the HLW/LAW combined option, the HLW melter feed tank, where dewatered Envelope D waste is blended with high activity products from the LAW process, has a potential for high enough inventory to exceed co-located worker exposure limits in case of a spill. The inventory of that tank is not included in the total inventory at risk from the DBE, because it is unrealistic to assume that the tank will be filled to capacity at the same time as all three HLW receipt tanks and the technetium/cesium product storage tank. However, engineered features to prevent or mitigate a spill from the HLW melter feed tank must be considered along with those for the systems included in the DBE.

For the toxic releases from the ammonia and nitric acid tanks, the tanks and their connections should be designed to prevent release of the gas under the forces provided by the earthquake.

4.7.3 Summary of Accident Analysis Results.{tc \l3 "4.7.3 Summary of Accident Analysis Results.}

This section summarizes the consequences of the accident scenarios selected for analysis and their comparison to the exposure standards. The accident analysis results are applied to mitigation needs for the suite of hazard analysis events with potential serious or major consequences listed in Table 4-28.

4.7.3.1 Summary of Consequences. Table 4-41 summarizes the radiological consequences of the accident analysis for those accidents presented in Section 4.7.2 that apply to the LAW-Only-option. Table 4-42 summarizes the radiological consequences of those accidents that apply to the HLW/LAW combined option.

Table 4-41. Summary of Radiological Consequences of Accidents for the LAW-Only Option

Section Number	Accident Scenario	Ground Level Release Consequences (rem)	Elevated Release Consequences (rem)

		Public	Co-located Worker	Public	Co-located Worker
4.7.2.1	LAW Receipt Tank Spill	0.057	99	0.008	0.036
4.7.2.3	Drop and Breach of Cesium Product Canister	0.020	37	0.003	0.013
4.7.2.5	Cesium Ion-Exchange Column Loss of Cooling	0.62	1120	0.082	0.41
4.7.2.6	Cesium Product Canister Pressurized Release	2.4	4310	0.31	1.6
4.7.2.10	Design Basis Earthquake	0.9	1650	Not calculated	Not calculated

Table 4-42. Summary of Radiological Consequences of Accidents for the HLW/LAW Combined Option

Section Number	Accident Scenario	Ground Level Release Consequences (rem)		Elevated Release Consequences (rem)	
		Public	Co-located Worker	Public	Co-located Worker
4.7.2.1	LAW Receipt Tank Spill	0.057	99	0.008	0.036
4.7.2.2	HLW Receipt Tank Spill	1.1	1820	0.15	0.69
4.7.2.4	Boiling of Cesium/Technetium Product Storage Tank	1.2	1360	No analysis required, release prevented	No analysis required, release prevented
4.7.2.5	Cesium Ion-Exchange Column Loss of Cooling	0.62	1120	0.082	0.41
4.7.2.7	HLW Melter Failure and Glass Spill	0.008	4.6	No analysis required	No analysis required
4.7.2.10	Design Basis Earthquake	4.5	8200	Not calculated	Not calculated

Table 4-43 provides the consequences of the accidents involving the release of toxic materials.

Table 4-43. Summary of Toxicological Consequences of Accidents

Section Number	Accident Scenario	ERPG-2 or TEEL-2[a]	Ground Level Release Consequences	
			Public	Co-located Worker

4.7.2.8	Ammonia Tank Spill	200 ppm	Does not exceed exposure standards	Exceeds exposure standard
4.7.2.9	Nitric Acid Tank Spill	38.6 mg/m^3	Does not exceed exposure standards	Exceeds exposure standard

[a] Emergency Response Planning Guidelines (ERPGs) are established by the American Industrial Hygiene Association for selected chemicals. Temporary Emergency Exposure Limits (TEELs) are interim, temporary or equivalent exposure limits for which official ERPGs have not yet been developed. TEELs have been adopted by DOE=s Subcommittee on Consequence Assessment and Protective Actions (SCAPA) and are documented in *ERPGs and TEELs for Chemicals of Concern at SRS* (Craig 1997).

4.7.3.2 Summary of Consequence Mitigation or Prevention. Accident scenarios developed in Section 4.7.2 were selected to represent the groups of events identified by the hazard evaluation teams as having potentially serious or major consequences to the public or worker. The unmitigated consequences of the accidents analyzed, along with consideration of the differences in material available for release and differences in dispersion phenomena, provide a measure of the potential severity of the consequences for the other events in the group. Need for consequence mitigation or prevention can then be examined for the events with potential for significant consequences.

Table 4-44 summarizes the application of features to mitigate or prevent consequences to the public and co-located worker for the events bounded by the accidents analyzed for the LAW only option.

Table 4-44. Summary of Events Bounded by Analyzed Scenarios for the LAW Only Option

Section Number	Bounding Accident Scenario	Other Scenarios Potentially Requiring Mitigation or Prevention
Liquid Release Scenarios		
4.7.2.1	LAW Receipt Tank Spill	0/26 - Transfer line break, leak to soil or to transfer pit.
		1614662/119 - Cs Neutralization Tank Overflow
Gas or Particulate Release Scenarios		
4.7.2.3	Breach of Cs Product Canister	No other scenarios with comparable source term and energy found.
Fire		
	No bounding analysis performed.	Investigation of potential fire scenarios not involving flammable gases indicated that fires resulting in significant exposure to the public or co-located worker are unlikely because of

Table 4-44. Summary of Events Bounded by Analyzed Scenarios for the LAW Only Option

Section Number	Bounding Accident Scenario	Other Scenarios Potentially Requiring Mitigation or Prevention
		insufficient combustible loading.
Flammable Gas Fire/Explosion		
4.7.2.5	Cs Ion Exchange Column Exothermic Reaction	1/11 and 1/18 - Flammable gas accumulation and explosion in ultrafilter
Overpressure		
4.7.2.6	Cs Product Canister Pressurized Release	1614667/120 - Overpressurization of Cs nitric acid recovery evaporator
		2200/13 and 2200/11 - Overpressurization of Cs ion exchange column
Glass Spill		
	None analyzed for LAW only option.	No glass spill scenario for the LAW only option is expected to result in significant consequence to public or co-located worker
Toxic Hazards		
4.7.2.9	Nitric Acid Spill in Cold Chemical Storage Area	1614667/131 - Damage to nitric acid stock tanks in Cs and Tc nitric acid recovery area
		1614775/399 - Spill of nitric acid in Cs product line cell

Table 4-45 summarizes the application of features to mitigate or prevent consequences to the public and co-located worker for the events bounded by each accident analyzed for the HLW/LAW combined option.

Table 4-45. Summary of Events Bounded by Analyzed Scenarios for the HLW/LAW Combined Option

Section Number	Bounding Accident Scenario	Other Scenarios Potentially Requiring Mitigation or Prevention
Liquid Release Scenarios		
4.7.2.2	HLW Receipt Tank Spill	0/26 - Transfer line break, leak to soil or to transfer pit.
		1614664/117 - Leak of Cs product tank
		1614662/119 - Cs neutralization tank overflow
		3200/220 - Leak of HLW melter feed vessel
		3200/160 - HLW melter feed vessel line break

Table 4-45. Summary of Events Bounded by Analyzed Scenarios for the HLW/LAW Combined Option

Section Number	Bounding Accident Scenario	Other Scenarios Potentially Requiring Mitigation or Prevention
Gas or Particulate Release Scenarios		
4.7.2.4	Boiling of Tc/Cs Product Storage Tank	1614666/129 - Loss of cooling to the HLW melter feed vessel
Fire		
	No bounding analysis performed.	Investigation of potential fire scenarios not involving flammable gases indicated that fires resulting in significant exposure to the public or co-located worker are unlikely because of insufficient combustible loading.
Flammable Gas Fire/Explosion		
4.7.2.5	Cs Ion Exchange Column Exothermic Reaction	1/11 and 1/18 - Explosion in ultrafilter
		1614666/122 - Flammable gas explosion in vapor space of the HLW melter feed tank
Overpressure		
4.7.2.5	Cs Ion Exchange Column Exothermic Reaction	1614667/120 - Overpressurization of Cs nitric acid recovery evaporator
		2200/13 and 2200/11 - Overpressurization of Cs ion exchange column
Glass Spill		
4.7.2.7	HLW Melter Failure	All glass spill events examined involve the HLW melter and result in smaller spills than the melter failure scenario analyzed.
Toxic Hazards		
4.7.2.9	Nitric Acid Spill in Cold Chemical Storage Area	1614667/131 - Damage to nitric acid stock tanks in Cs and Tc nitric acid recovery area

4.8 CONTROLS FOR PREVENTION AND MITIGATION OF ACCIDENTS{tc \l2 "4.8 CONTROLS FOR PREVENTION AND MITIGATION OF ACCIDENTS}

The results of the safety analyses are used to identify the engineered and administrative controls needed to maintain exposures within the limits specified in Table 4-27 (for radiological) and the ERPG-2 (AIHA 1988) (for chemical). In selecting engineered and administrative controls for the protection of worker and public safety, preference is given to engineered features over administrative controls. Preference is also given to passive over active engineered features. Engineered and administrative controls credited for satisfying the radiological or chemical exposure standards for the protection of the public are the basis for Technical Safety Requirements (TSRs).

Engineered and administrative controls credited for satisfying the radiological or chemical exposure standards established for the protection of the workers are the basis for LCRs.

The selection of engineered and administrative controls is based upon the conceptual design of the facility. Additional or different features may be identified during Part B.

4.8.1 Engineered Features{tc \l3 "4.8.1 Engineered Features}

This section discusses the Design Class I and II engineered features required to maintain the public and worker radiological exposure standards within the limits of Table 4-27 and the chemical standards in ERPG-2 (AIHA 1988).

4.8.1.1 Design Class I Engineered Features. For the HLW/LAW option, failure of the HLW receipt tanks during a DBE challenges the public exposure standard of Table 4-27 as discussed in Section 4.7.2.10, ADesign Basis Earthquake.@ As such, the HLW receipt tanks are designated as Design Class I.

There are no Design Class I engineered features required for the LAW-Only option.

4.8.1.2 Design Class II Engineered Features. There are a number of Design Class II engineered features selected and proposed for protection of the workers. Accidents addressed in Section 4.7, AResults of the Integrated Safety Assessment@ and in Tables 4.6-41, 42, and 43 that require these engineered features for prevention or mitigation are:

1) Radiological releases within process cells that could exceed the radiological exposure standards for the workers if they were released into the operating areas or outside the building at ground level

2) Release of chemicals that could exceed the chemical exposure standards.

These Design Class II items primarily protect the co-located worker.

In addition, there are hazardous situations identified in the fault schedules of the HAR (BNFL 1997d) that require prevention or mitigation. These are:

1) Out-of-cell accidents that primarily impact the facility worker (e.g., inadvertent opening of a shield door)
2) Interactions between radiation and non-radiation areas (e.g., pressure reversals).

These Design Class II items primarily protect the facility worker.

Tables 4-46 and 4-47 provide a potential list of Design Class II engineered features for accident prevention and mitigation.

4.8.2 Administrative Controls{tc \l3 "4.8.2 Administrative Controls}

Administrative controls are requirements to perform activities, restrictions to prevent activities, or requirements to maintain parameters. Typically, TSRs and LCRs are administrative controls created to provide assurance of the continued operability of engineered features. An interlock is an example of an engineered feature installed to prevent an action if certain conditions are not satisfied. The corresponding administrative control requires that a specific test be conducted on the interlock to verify the component remains operable.

TSRs and LCRs may be required to provide assurance that a process variable, design feature, and operating restriction that was used as an initial condition for an accident analysis that relates to public safety (TSR) or worker safety (LCR) is maintained. An example would be maintenance to the stack flow credited in the calculation of the of the atmospheric dispersions for elevated releases.

Some TSRs or LCRs are administrative controls that require or prohibit activities when no engineered feature exists to provide the protection required. Credit may be taken for a specific operator action in response to parameters. If there is no designed engineered feature that performs this action, the requirement for the operator to complete the activities is considered to be an administrative control.

Controls by LCRs and TSRs are not established for passive features credited for worker or public safety if the passive features are not manipulated during normal operation. The configuration management process described in Section 3.1, AConfiguration Management,@ provides control of the design, installation, and maintenance of these passive engineered features.

4.8.2.1 Technical Safety Requirements. The Design Class I SSCs identified in Section 4.8.1.1, ADesign Class I Engineered Features,@ are passive features that are not manipulated during operations. As such, no TSRs are required for these components. In addition, no TSRs are required to control process variables, design features, and operating restrictions that are the initial conditions for accident analysis that relate to public safety. Should the need for TSRs be established in Part B, they would be prepared in accordance with Safety Criterion 9.0-3 of SRD Volume II (BNFL 1997g).

4.8.2.2 Licensee Controlled Requirements. Section 4.7, AResults of the Integrated Safety Assessment,@ identifies the need for a process cell ventilation system and stack to achieve compliance with the co-located worker radiological exposure standard of Table 4-27. LCRs may also be required to control process variables, design features, and operating restrictions that are the initial conditions for accident analysis for worker safety. For the TWRS-P Facility, such as LCR, relates to the stack flow and temperature assumed in the determination of the atmospheric dispersion coefficients. An example LCR for process cell ventilation system is provided as Figure 4-31. The conditions, required actions, completion times, and surveillance requirements included in Figure 4-31 and only provided as examples. The section also provides the format and content for LCRs for the TWRS-P Facility.

Table 4-46. Design Class II Structures, Systems, and Components for HLW/LAW (Sheet 193)

Structure, System, or Component (SSC)	Specified Safety Function	Licensee Controlled Requirement
Prevention and Mitigation Features Required Primarily for Protection of the Co-Located Worker		

Table 4-46. Design Class II Structures, Systems, and Components for HLW/LAW (Sheet 193)

Structure, System, or Component (SSC)	Specified Safety Function	Licensee Controlled Requirement
(the C5 extract systems equally protects the facility worker)		
LAW receipt tanks (2)	Prevent tank failure during a DBE (Section 4.7.2.10)	None, passive feature
Cesium/Technetium product storage tank	Prevent tank failure during a DBE (Section 4.7.2.10)	None, passive feature
HLW melter feed tanks (2)	Prevent tank failure during a DBE (Section 4.7.2.10)	None, passive feature
HLW ultrafilters (2)	Prevent tank failure during a DBE (Section 4.7.2.10)	None, passive feature
Nitric acid storage tank	Prevent tank failure during a DBE (Section 4.7.2.9)	None, passive feature
Ammonia storage tank	Prevent tank failure during a DBE (Section 4.7.2.8)	None, passive feature
Nitric acid storage tank barrier protection	Protection tanks from physical damage that could cause the tank to fail (Section 4.7.2.9)	None, passive feature
Ammonia storage tank barrier protection	Protection tanks from physical damage that could cause the tank to fail (Section 4.7.2.8)	None, passive feature
C5 extract system (including the ductwork, stack, and fans but not the filters)	Provide for radionuclide removal and elevated release for the process cells containing the HLW and LAW receipt tanks, HLW melter feed tanks, ultra-filters and the cesium ion exchange column (Sections 4.7.2.1, 4.7.2.2, and 4.7.2.5)	Yes
Leak isolation for the ammonia system	Isolate the ammonia storage tanks from downstream leaks in the ammonia system (Section 4.7.2.8)	Yes
Leak isolation for the nitric acid system	Isolate the nitric acid storage tank from downstream leaks in the nitric acid system (Section 4.7.2.9)	Yes
Support systems for the C5 extract system and the ammonia and nitric acid isolation systems	Provide electrical power, instrumentation and control, and instrument air as needed to allow	Yes

Table 4-46. Design Class II Structures, Systems, and Components for HLW/LAW (Sheet 193)

Structure, System, or Component (SSC)	Specified Safety Function	Licensee Controlled Requirement
acid isolation systems	the C5 extract system and the ammonia and nitric acid isolation systems to perform their specified safety functions (Sections 4.7.2.1, 4.7.2.2, and 4.7.2.5)	
Prevention and Mitigation Features Required Primarily for Protection of the Facility Worker		
Limit switches on hoists	Limit lift height of containers such that, for an out-of-cell drop, the container will not fail.	Yes
Detection and isolation of condensate, effluent, and cooling water streams.	Detect and isolate leaks to prevent contaminating portions of systems with activity that would challenge the worker exposure standards	Yes
C3 extract system	To prevent radiological release to operating areas	Yes
Isolation valves or loop seals for inactive feed lines	Prevent backflow of radioactive material into operating areas	Yes
Instrumentation on air supplies to in-cell systems (e.g., air purge and air in-bleed)	Prevent backflow of radioactive material into operating areas	Yes
Instrumentation of ion exchange columns	Prevent resin degradation and the potential for overpressurization of the column and release of radioactivity	Yes
Instrumentation on ion exchange discharge route from columns	Prevent inadvertent discharge of ion exchange resin (SL 644 only) to the evaporator and contact with strong acid	Yes
Instrumentation of ammonia feed to the SCR and SCR system	Protect against formation of ammonium nitrate	Yes
Interlock system for shield doors	Protect against inadvertent opening of shield door when a high radiation source is present	Yes

Table 4-47. Design Class II Structures, Systems, and Components for LAW-Only (Sheet 1)

Structure, System, or Component (SSC)	Specified Safety Function	Licensee Controlled Requirement
Prevention and Mitigation Features Required Primarily for Protection of the Co-Located Worker (the C5 extract systems equally protects the facility worker)		
LAW receipt tanks (2)	Prevent tank failure during a DBE (Section 4.7.2.10)	None, passive feature
Cesium neutralization tank	Prevent tank failure during a DBE (Section 4.7.2.10)	None, passive feature
Cesium product canister storage racks	Prevent canister failure during a DBE (Section 4.7.2.3)	None, passive feature
Nitric acid storage tank	Prevent tank failure during a DBE that could fail the tank (Section 4.7.2.9)	None, passive feature
Ammonia storage tank	Prevent tank failure during a DBE that could fail the tank (Section 4.7.2.8)	None, passive feature
Nitric acid storage tank barrier protection	Protection tanks from physical damage (Section 4.7.2.9)	None, passive feature
Ammonia storage tank barrier protection	Protection tanks from physical damage (Section 4.7.2.8)	None, passive feature
C5 extract system (including the ductwork, stack, and fans but not the filters)	Provide for radionuclide removal and elevated release for the process cells containing the LAW receipt tanks, cesium neutralization tank, the stored cesium product canisters, and the cesium ion exchange column (Sections 4.7.2.1, 4.7.2.3, 4.7.2.5, and 4.7.2.6)	Yes
Leak isolation for the ammonia system	Isolate the ammonia storage tanks from downstream leaks in the ammonia system (Section 4.7.2.8)	Yes
Leak isolation for the nitric acid system	Isolate the nitric acid storage tank for downstream leaks in the nitric acid system (Section 4.7.2.9)	Yes
Support systems for the C5 extract system and the ammonia and nitric acid isolation systems	Provide electrical power, instrumentation and control, and instrument air as needed to allow the C5 extract system and the ammonia and nitric acid isolation systems to perform their specified safety function (Sections 4.7.2.1, 4.7.2.3, 4.7.2.5, and 4.7.2.6)	Yes

Table 4-47. Design Class II Structures, Systems, and Components for LAW-Only (Sheet 1)

Structure, System, or Component (SSC)	Specified Safety Function	Licensee Controlled Requirement
Prevention and Mitigation Features Required Primarily for Protection of the Facility Worker Same as provided in Table 4-46.		

Safety Limits: Contains the limits on the process variables. If a safety limit for the facility is exceeded, the facility is immediately placed in a stable, safe condition, including shutdown, except where such action might reduce the margin of safety. The safe, stable condition entered as a corrective action is maintained until DOE authorizes further operations.

Limiting Conditions for Operation (LCOs): Contains the safety limits on functional capability or performance level. If an LCO is not met, remedial actions are taken as specified by the LCRs until the condition can be met. The LCOs are based on:

1) Process variables, design features, and operating restrictions that are the initial conditions for accident analysis that relate to worker safety, and

2) Structures, systems, and components that must function to prevent or mitigate accidents to achieve compliance to the worker radiological and chemical exposure standards of SRD Safety Criteria 2.0-1 and 2.0-2 (BNFL 1997g).

Surveillance Requirements: Contains the surveillance requirements necessary to maintain operation of the facility within the safety limits and LCOs. If a required surveillance is not successfully, the systems or components involved is assumed to be inoperable and actions defined by LCOs are be taken until the systems or components can be shown to be operable.

Administrative Controls: Contains the requirements associated with administrative controls important to protect the health and safety of the worker, including those for reporting violations of the LCRs. Staffing requirements for facility positions important to safe operation of the facility are included in the administrative controls section of the LCRs. Commitments to the safety management programs identified in the FSAR as necessary components of the facility safety basis are provided in this section.

Use and Application: Contains the basic instructions for applying the safety restrictions contained in the LCRs. Definitions of terms, operating modes, frequency notations, and actions to be taken in the event of violations of LCOs or surveillance requirements are to be included in this section.

Bases: Provides a summary statements of the reasons for the LCOs and associated surveillance requirements. The basis show how the numeric value, the condition, or the surveillance fulfills the purpose derived from the safety documentation. The primary purpose for describing the basis of each requirement is to ensure that any future changes to the requirement will not affect its original intent or purpose.

LCR A C5 Extract System

LCO A.B The C5 Extract System shall be operable.

APPLICABILITY: With feed in an LAW receipt tank, resins in an ion exchange column, or handling of a cesium product canister

ACTIONS

Condition	Required Action	Completion Time
A. One required extract fan inoperable.	A.1 Restore required fan to OPERABLE status.	Eight hours
B. Two required extract fans inoperable.	B.1 Verify C1, C2, and C3 fans have tripped	Immediately
	AND	
	B.2 Verify air supplies to process cells have isolated	Immediately
	AND	
	B.3 Initiate controlled shut down	15 minutes
C. Required Action and associated Completion Time of Condition A not met.	C.1 Shut down processing operations.	12 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
NOTE - Not required to be performed until 1 hour after C5 extract system is placed in service. - SR A.B.1 Verify operating area to process cell differential pressure is $ 1/4 inches of water.	4 hours
SR A.B.2 Verify C5 stack flow is $ 196 ft^3/sec	24 hours
SR A.B.3 Verify C5 stack gas temperature $ 68 F	24 hours

4.9 ADMINISTRATIVE CONTROL OF THE INTEGRATED SAFETY ANALYSIS{tc \l2 "4.9 ADMINISTRATIVE CONTROL OF THE INTEGRATED SAFETY ANALYSIS}

The PHA and the accident analysis were initially performed to support Part A activities. As the project matures through construction startup, operation, and deactivation, these analyses are reviewed and revised. If the revision to the PHA affects the HAR, the HAR is revised to reflect the changes. Prior to operation, the results of changes to the accident analysis are reflected in revisions to the PSAR and after the beginning of operation in the FSAR. The PHA records, the HAR, PSAR, and FSAR are controlled as described in Section 3.8, ARecords Management.@ Changes to the HAR, PSAR, and the FSAR are also subject to the provisions of the configuration management process described in Section 3.1, AConfiguration Management.@ The involvement of the regulator in changes to the ISA is addressed in Section 3.3.3, AChanges to Safety Documentation@ of the *Integrated Safety Management Plan*, (BNFL 1997e).

The PHA and the accident analysis are revised early in Part B to form the basis for more detailed hazard identification and accident analysis to support developing design and the construction authorization request. After construction authorization is granted and prior to operation, the HAR, the PHA, and the accident analysis are reviewed every two years. Another update of the analyses is required to support the operating authorization request. Following operating authorization, the PHA is reviewed every five years as required by 40 CFR 68, *Chemical Accident Prevention Provisions*. Revisions needed as a result of these reviews are controlled as described above.

During the operations phase, changes made to the FSAR or the HAR are provided annually to the regulator as updates to the license basis documents. The first update is issued within 12 months following operating authorization. The following annual updates reflect changes implemented 3 months prior to the updates.

In addition to these scheduled reviews, the TWRS-P Facility configuration management program ensures consistency among design, engineered and, administrative controls, safety analysis, and safety documentation throughout the design, construction, operation and deactivation phases. Proposed changes to the facility design and administrative controls are reviewed for their impact on safety analysis and documentation by the configuration management processes described in Section 3.1, AConfiguration Management.@ The configuration management process ensures that changes are made to the safety analysis and safety documentation to reflect the changes in design and administrative controls. The configuration management processes also requires review for the potential creation of an unreviewed safety question (see Section 3.12, AUnreviewed Safety Question Evaluation.@)

Periodic audits are performed to evaluate compliance with the elements of the ISA and include the performance of PHA and the accident analysis. These compliance audits are performed by individuals knowledgeable of the ISA process. Additional detail on the audit program is Section 3.6, AAudits and Assessments.@

5.0 RADIATION SAFETY{tc \l1 "5.0 RADIATION SAFETY}

This chapter summarizes the provisions for radiation safety of Tank Waste Remediation System-Privatization (TWRS-P) Facility workers, co-located workers, the public, and the environment. The facility radiation safety philosophy and requirements to protect individuals on the TWRS-P Facility property are documented in Appendix 5A, ARadiation Protection Program Outline.@ The facility radiation protection philosophy and requirements to protect individuals and the environment outside the TWRS-P Facility property are documented in Appendix 5B, AEnvironmental Radiological Protection Program Outline.@ The radiation protection program (RPP) requirements selected are based on applicable regulatory and other standards to ensure protection of personnel and the environment against the types and magnitudes of hazardous situations identified in Chapter 4.0, AIntegrated Safety Analysis.@

Since the TWRS-P Facility is a privately-owned facility that conducts waste treatment activities for the U.S. Department of Energy (DOE) on the Hanford Site, Code of Federal Regulations (CFR) 10 CFR 835, AOccupational Radiation Protection,@ is the applicable regulatory standard. This chapter describes the essential elements of the RPP that define the radiological safety basis. The RPP complies with 10 CFR 835 as provided in the TWRS-P Facility contract. However, since the facility eventually may be licensed by the U.S. Nuclear Regulatory Commission (NRC), the RPP is also tailored to accommodate transition to regulation under 10 CFR Part 20, AStandards for Protection Against Radiation.@

The specific standards applicable to the RPP are provided in the TWRS-P Facility safety requirements document (SRD) (BNFL 1997g). Where beneficial to worker radiation safety, elements of other nonregulatory standards (e.g., *Hanford Site Radiological Control Manual* [HSRCM-1]) are also used as references for development of occupational RPP requirements.

DOE activities, as defined by 10 CFR 835, include A....an activity for or by DOE that has the potential to result in the occupational exposure of an individual to radiation or radioactive material.@ This definition continues, identifying that AThe activity may be, but is not limited to, design....@ The RPP for the design of TWRS-P must be approved by the DOE, as specified in Section 101 of 835, before significant design is undertaken that can influence the potential exposure of an individual. BNFL Inc. Has determined that substantive facility design can begin when: 1) facility layout and equipment location is firm, 2) description of process elements is finalized, and 3) volumes are fixed allowing identification of source term values. The RPP for design will consist primarily of the provisions for design that will govern the ALARA design trade-offs and optimizations.

There are very few activities involving radioactivity or radioactive materials during normal construction operations. Of these, radiography is the principle activity. Because radiography is performed by NRC-licensed subcontractors who are responsible for the safe operation of their equipment, only a minimal construction radiation protection program is required for TWRS-P Facility. Consequently, during the construction phase, BNFL implements a standard industrial safety radiation protection program to cover this type of work. This program is typical of those used on any large construction project, and includes the procedures and training necessary to ensure construction workers follow Hanford Site requirements for sheltering or evacuation during releases from other Hanford Site areas. However, the RPP for the construction phase requires DOE approval.

The exception to the above is construction activities involving tank 241-AP-106, which contains radioactive material. These activities include modifications to the tank ventilation system and the connection of TWRS-P Facility transfer lines to the tank. For these activities, the radiation protection program established for operating the TWRS-P Facility is used to ensure the work is performed with an adequate level of safety.

(There may be radioactively contaminated soil on the TWRS-P Facility site. Such areas are to be characterized under the DOE Site Characterization Study prior to the start of the construction. Furthermore, to ensure protection of workers, appropriate sampling programs are performed through BNFL=s environmental monitoring program in accordance with the BNFL TWRS-P Project contract. In the event of previously undetected area of contamination is found, work in the area is suspended, samples taken, and necessary remediation activities performed.)

5.1 AS LOW AS IS REASONABLY ACHIEVABLE (ALARA) POLICY AND PROGRAM{tc \l2 "5.1 AS LOW AS IS REASONABLY ACHIEVABLE (ALARA) POLICY AND PROGRAM}

The following statements provide the basis for the TWRS-P Facility policy on radiation exposures to workers and to the public.

1) ALARA - Personal radiation exposure shall be maintained as low as reasonably achievable (ALARA). Radiation exposure of the workforce and public during routine operation shall be controlled so radiation exposures are maintained well below regulatory limits and so that radiation exposure is balanced against commensurate benefit.

2) Ownership - Each individual involved in radiological work must demonstrate responsibility and accountability through an informed, disciplined, and conservative attitude toward radiation and radioactive material.

3) Excellence - Excellent performance is evident when radiation exposures are maintained below regulatory limits, contamination is minimal, radioactive material is well controlled, and radiological spills are prevented. Continuing improvement is essential to excellent radiological control.

The TWRS-P Facility ALARA program adopts the pertinent program elements outlined in the BNFL Corporate Health and Safety Manual, Volume 3, *Codes of Practice - Application of ALARP to the Routine Radiation Exposure of Workers and the Public* (BNFL 1994). The concepts in this document have been successfully implemented at other BNFL-operated nuclear facilities. In addition, the applicable portions of *Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels That Are as Low as Reasonably Achievable (ALARA)* (Munson 1988), and Regulatory Guide 8.10, Revision 1R, *Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable* (NRC 1975) are used to guide development of the ALARA Program. The ALARA concept bounds the as low as reasonable and practicable (ALARP) philosophy, and for TWRS-P project application the two are considered equivalent.

The functional elements of the facility ALARA program are incorporated into the RPP and into facility operations so ALARA concepts are an integral part of daily operation. The ALARA program is documented, proceduralized, and performance is reported to the TWRS-P Facility Manager on a regular basis. The Radiation Protection organization provides technical input as appropriate and all facility workers participate in maintaining exposures ALARA. The program establishes, tracks, and reports the status of readily measurable performance indicators such as exposure, exposure rate, and contamination control goals. The data collected is used for trend analysis to establish where the program has been, the current status, and to help decide on future program directions.

The ALARA program is guided by the facility ALARA Committee, a subcommittee to the Project Safety Committee, chartered to examine potential radiological exposure reduction opportunities and to make recommendations to facility management. Committee responsibilities include the following:

1) Convening on a regular basis

2) Setting facility ALARA goals, consistent with corporate goals, on an annual basis

3) Tracking status, monitoring progress toward goals, and making adjustments to goals as appropriate

4) Providing support, as requested, to implement recommendations

5) Providing activity reports and goal status to facility senior management

6) Providing an annual report of activities and accomplishments

7) Performing annual RPP review.

The ALARA Committee consists of a chairperson and one member of each of the facility organizations listed below:

1) Facility Management
2) Operations
3) Operations Support
4) Engineering
5) Maintenance
6) Environment, Safety, and Health.

Each member of the ALARA Committee has their manager's active endorsement and support in conducting committee business. Support, both technical and administrative, is available at a level sufficient to support the ALARA Committee charter and to accomplish its goals.

5.2 ORGANIZATIONAL RELATIONSHIPS AND PERSONNEL QUALIFICATIONS{tc \l2 "5.2 ORGANIZATIONAL RELATIONSHIPS AND PERSONNEL QUALIFICATIONS}

The Radiation Protection organization, key personnel within the organization, staffing levels, and interfaces with other facility organizations are discussed in Chapter 2.0 AManagement Organization@. This section describes the relationship between the Radiation Protection organization and other facility organizations and identifies key RPP positions and responsibilities.

The Radiation Protection organization supports management to help maintain control of radiological hazards within the TWRS-P Facility. This organization reports to the Manager of Environment, Safety, & Health, who in turn reports to the General Manager.
Key positions within the Radiation Protection organization are the Radiation Protection Manager; the Facility Analyst, Specialist, or Radiological Engineer; and the Radiation Protection Technician (RPT). Their responsibilities are:

1) Radiation Protection Manager

   - Manages the Radiological Protection organization and the technical support that organization provides to the safe operation of the facility

   - Provides technical radiation safety consulting to other TWRS-P Facility organizations

   - Ensures the required radiation protection program elements are in place and maintained current.

2) Facility Analyst, Specialist, or Radiological Engineer

   - Provides technical support for RPP activities. (Technical support includes review of survey reports, development and review of procedures, radiological data review, documenting the radiological status of the facility, and applying knowledge and experience to resolve technical radiological safety problems).

3) Radiation Protection Technician

   - Conduct the RPP activities that ensure control of radiological contamination, personnel exposures, and environmental protection.

Personnel must possess a minimum level of training and experience to maintain a key position within the TWRS-P Facility radiation protection organization. The minimum qualifications for key personnel and their associated responsibilities are detailed in Section 2.4 of the RPP. Personnel qualification requirements are based upon DOE (HSRCM-1) and other U.S. industry standards.

5.3 RADIOLOGICAL SAFETY STANDARDS AND ADMINISTRATIVE CONTROL LEVELS{tc \l2 "5.3 RADIOLOGICAL SAFETY STANDARDS AND ADMINISTRATIVE CONTROL LEVELS}

The primary purpose of the RPP is to control personnel radiation exposures and, thus, control risks to personnel from radiological hazards. To accomplish this, a number of standards and administrative controls are employed within the RPP. The radiological exposure standards adopted have been determined by BNFL Inc., the TWRS-P Project regulators, and national and international scientific organizations to afford adequate protection from risks associated with occupational exposures. Therefore, conducting facility operations within these standards ensures an adequate level of personnel protection from occupational radiation exposures.

5.3.1 Regulatory Standards and Definitions{tc \l3 "5.3.1 Regulatory Standards and Definitions}

The regulatory standards applicable to the TWRS-P Facility are specified in 10 CFR 835. The occupational exposure limits are presented in Table 5-1.

Table 5-1. Statutory Limits for Occupational Radiation Exposures

Target Organ	Annual Statutory Limits rem (sievert)
Total effective dose equivalent	5 rem (0.05)
Summation of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye	50 rem (0.5)
Lens of the eye dose equivalent	15 rem (0.15)
Shallow dose equivalent to the skin or to any extremity.	50 rem (0.5)

The regulatory standards for the control of contamination levels within the facility and for the release of personnel, materials, and equipment from radiological and controlled areas are presented in Table 5-2.

Table 5-2. Radioactivity Values (dpm/100 cm^2)

Nuclide	Removable	Total (Fixed+Removable)
U-nat, U-235, U-238, and associated decay products	1,000	5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	1,000	5,000

The regulatory definitions of radiological and controlled areas are presented below.

1) *Airborne Radioactivity Area* - Any facility area where the airborne concentration of radioactive materials above natural background exceeds 10% of the derived air concentration (DAC) value, or where an individual could receive a weekly exposure in excess of 12 DAC-h (10 CFR 20).

2) *Contamination Area* - Any area where surface contamination levels are greater than the values specified in Table 5-2, but less than or equal of 100 times those levels.

3) *Controlled Area* - Any area, inside the site boundary, access to which is limited by the TWRS-P Facility. Individuals who enter only controlled areas without entering radiological areas are not expected to receive a total effective dose equivalent of more than 0.1 rem (0.001 sievert) in one year.

4) *High Contamination Area* - Any area where surface contamination levels are greater than 100 times the values specified in Table 5-2.

5) *High Radiation Area* - Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 h at 30 cm from the radiation source or from any surface that the radiation penetrates.

6) *Radiation Area* - Any area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 h at 30 cm from the source or from any surface that the radiation penetrates.

7) *Very High Radiation Area* - Any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 h at 1 m from a radiation source or from any surface that the radiation penetrates.

5.3.2 Administrative Occupational Exposure Limits{tc \l3 "5.3.2 Administrative Occupational Exposure Limits}

Occupational radiation exposures at the TWRS-P Facility are controlled to less than statutory limits. To ensure this, the facility has adopted design and operational administrative control levels significantly below the statutory limits. Further, during operations, occupational exposures are maintained as far below administrative control levels as is reasonably achievable. Table 5-3 lists the administrative control levels adopted by the TWRS-P Facility and includes the statutory limits for comparison.

Table 5-3. Statutory and TWRS-P Facility Annual Administrative Control Levels

Target Organ	Administrative Control Levels (rem)	Statutory Limits (rem)
Total effective dose equivalent	1	5
Summation of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye	10	50
Lens of the eye dose equivalent	3	15
Shallow dose equivalent to the skin or to any extremity.	10	50

5.3.3 Facility Radiation Control Zones{tc \l3 "5.3.3 Facility Radiation Control Zones}

The TWRS-P Facility is designed as a heavily shielded facility to aid in controlling external occupational radiation exposures. The five radiation control zones (R1 - R5) are presented in Table 5-4. The initial radiation design goals are listed for each zone. A maximum radiation exposure rate during operations is specified for each zone. The target exposure rate is a general area design goal that retains flexibility to accommodate projected area occupancy rates. After the initial design establishes exposure rates that are within the goals, further ALARA review determines if further reductions in the projected exposure rates is cost effective. The Preliminary Safety Analysis Report (PSAR) will contain the facility radiation shielding diagrams.

Table 5-4. Radiation Control Zones

Classification	Target Radiation Levels (mrem/hour)	Maximum Radiation Levels (mrem/hour)
R1 - Unrestricted Area	<0.01	0.025
R2 - Controlled Area	<0.025	0.05
R3 - Radiation Area (Average)	<0.5	10
R4 - Radiation Area (Maximum)	<25	100
R5 - High/Very High Radiation Area	Dependent on projected occupancy - no routine or frequent occupancy.	Unlimited

5.3.4 Facility Contamination Control Zones{tc \l3 "5.3.4 Facility Contamination Control Zones}

The TWRS-P Facility design contains five distinct contamination zones that provide a graded level of contamination control. The graded approach requires the application of increased engineered and administrative controls to those facility areas that have higher levels of dispersible radioactive materials. For example, the area with the greatest dispersible radioactive material source term (i.e., vessel area) has the largest negative differential air pressure with respect to both the other facility areas and to the atmosphere. This concept ensures air flow from uncontaminated areas toward the most contaminated process areas preventing the dispersion of radioactive contamination within the facility. A description of each zone by its classification, the anticipated surface contamination and airborne levels, and examples of typical controls are provided in Table 5-5.

Table 5-5. TWRS-P Contamination Control Zones

Zone Classification	Typical Control	Expected Surface Contamination (dpm/100 cm^2)		Mean Airborne Contamination DAC
		Alpha	Beta	
C1	Routine monitoring	<20 (removable)	<1,000 (removable)	<0.01
C2.	Remove outer protective clothing. Wash and monitor on exit	<24 k	<240 k	0.01 - 0.03
C3	Subchange provisions. Shoe cover change. Change outer	24 k	240 k	0.1 - 1.0

	protective clothing (PCs) when necessary. Respiratory protection. Full body survey.			
C4	High-integrity PCs, respirators, full body survey.	240 k	2,400 k	~10
C5	No routine access	>C4		

5.3.5 Radiological Work Practice Standards{tc \l3 "5.3.5 Radiological Work Practice Standards}

Superior, consistent performance in radiological protection is achieved by having qualified facility personnel use approved procedures and by management actively monitoring the workplace and assessing ongoing activities. Frequent review and informed interest by management, particularly senior management, is key to achieving and maintaining successful superior implementation of the RPP. Implementation is accomplished as follows:

1) Management at all levels requires high standards for radiation safety through direct communication, instruction, and inspection of the workspace.

2) Facility management has a basic knowledge of radiation, its effects, and radiation safety requirements.

3) All work is conducted in radiological areas, and work affecting radioactive materials or using radiation generating-devices is conducted in accordance with approved procedures.

4) Facility management is familiar with the current radiological performance record.

5) Each individual involved in radiological work demonstrates responsibility and accountability through an informed, disciplined, and conservative attitude toward radiation and radioactive material.

6) Personnel make optimal use of management controls, engineered controls, safety training, and protective equipment.

7) The organizational structure requires direct-line accountability for program performance.

8) Radiological controls are incorporated into the facility performance goals program

9) Radiation protection expertise is incorporated into facility procedure development, design change development, and incident investigation.

Occupational radiation exposures at the TWRS-P Facility are not allowed to exceed the statutory limits. In addition, a primary facility goal is to maintain exposures below facility administrative limits. The only exceptions for personnel to exceed administrative exposure levels are by written facility manager approval under the conditions specified in the RPP. The design, operational, and administrative control features of the facility aid in achieving this level of exposure control.

In addition, radiological areas within the facility are characterized, identified, and posted to alert workers to the radiological hazards in the work environment. The TWRS-P Facility radiological areas with the characteristics defined in Section 5.3.1 are conspicuously posted and controlled as specified in the RPP. With respect to radioactive contamination, the standards listed in Table 5-2 are used to control the levels of contamination within the facility and the release of personnel, materials, and equipment from radiological controlled areas.

Access and exit requirements for the facility radiological areas are provided in the RPP and implemented in the applicable radiation work permits (RWPs). For example, personnel exiting the facility contamination areas or high contamination areas are monitored for surface contamination after removing protective clothing. The requirement for monitoring, as well as the type of survey are specified in the applicable RWP.

5.4 RADIATION SAFETY PROCEDURES AND RADIOLOGICAL WORK PERMITS{tc \l2 "5.4 RADIATION SAFETY PROCEDURES AND RADIOLOGICAL WORK PERMITS}

All TWRS-P Facility work or activities involving radioactive materials or radiological hazards are controlled by approved written procedures. Radiation safety requirements may be placed in RWPs, facility technical work documents (e.g., general work procedures), or both. The RWPs and facility technical work documents that involve radiological hazards are reviewed and approved by the Radiation Protection organization. This review ensures incorporation of radiation protection features (e.g., adequate protective clothing, containment devices, local ventilation, and general exposure controls) into routine and nonroutine work procedures. In addition RWPs specify the radiological safety controls to be applied to specific work or specific work locations (e.g., radiological areas).

The RWPs may have either general or specific applications and are developed based on existing or anticipated radiological conditions. General RWPs are limited to well-defined types of work that occur over a long time and are repetitive or routine in nature. Examples include radiation protection surveys, routine tours and inspections of areas where radiological conditions are stable, and activities that do not involve work with elevated, changing, or complex radiological conditions, as determined by the Radiation Protection organization. The valid lifetime of a general RWP does not exceed one year.

Specific RWPs are used to perform work that does not meet the criteria for general RWPs. Examples are one-time or short-term radiological work, work within temporary radiological areas, or work involving significant changes to radiological conditions during the course of the task. The valid lifetime of a specific RWP is for the length of the task and not to exceed 90 days. A one-time extension of up to 30 days may be granted after the Radiation Protection Manager's review.

The RWP development, review, and approval process is specified in the RPP. New RWPs may be initiated by either the TWRS-P Facility Radiation Protection organization, Maintenance organization, or Operating organization, however, the cognizant radiological engineer is the first designated Radiation Protection organization technical reviewer and approval authority. The Radiation Protection Manager provides the final required Radiation Protection organization approval. The Facility Manager, or designee, approves general RWPs because of their long term or routine nature. The appropriate facility safety organization also reviews RWPs that contain requirements addressing nonradiological hazards. Typically, RWPs include the following information:

1) Valid scope of work for which the RWP
2) Entry and exit requirements
3) Required personal protective equipment
4) Anticipated or actual radiological conditions
5) Limiting radiological conditions for the RWP
6) Level of RPT coverage
7) Expiration date and approval signatures
8) Any special instructions and appropriate nonradiological safety controls
9) A unique RWP identification number.

The RWPs are only valid for the period of time specified on the document. Should radiological conditions exceed the RWP limits, work must be halted immediately after placing the area in a safe condition. Work is allowed to restart after the cause of the radiological problem is identified and corrected and the RWP is reviewed for continued applicability. In addition, the pertinent RWPs are reviewed when problems occur, such as personnel contamination or exceeding an administrative control level.

The Radiation Protection Manager may authorize work without an approved RWP to respond to conditions requiring immediate action. The authorization is documented along with the controls applied to the response as specified in the RPP.

For a period of two years after the expiration date, the original and revisions of each RWP and program procedure are maintained using an easily retrievable for reference purposes. After two years, the RWP records are maintained according to the Records Management System.

The RPP implementation procedures are used to guide the daily operating activities of the Radiation Protection organization. These procedures are internal to the Radiation Protection organization, and must be approved by the Radiation Protection Manager. The RPP and all associated procedures are reviewed on an annual basis, or whenever procedural changes are considered. These procedures may be modified by the Radiation Protection Manager as long as the modifications do not alter the RPP commitments. Modification of the RPP requires approval by the DOE-Regulatory Unit.

5.5 TRAINING{tc \l2 "5.5 TRAINING}

The occupational radiation protection training program is a vital management tool for supporting safe operations at the TWRS-P Facility. Adequate training helps to ensure that facility personnel perform work in a manner that is both efficient and provides the greatest margin of personnel and facility safety. It is TWRS-P Facility policy that all general employees complete the required training prior to entering facility radiological areas or incurring occupational exposure within the facility.

The training program meets the requirements of 10 CFR 835, Subpart J, ARadiation Safety Training@; 10 CFR 19, ANotices, Instructions and Reports to Workers: Inspection and

Investigations@; and 10 CFR 20. Radiation protection training is required for three categories of facility workers. These categories and their definitions are as follows:

1) General Employee - Individuals who are employed (full- or part-time) at the facility an employee of a subcontractor assigned to the facility, assigned oversight personnel, or visitors who either perform work within the facility or are not escorted within the facility. General employees that do not enter radiological areas or work directly with radioactive materials are also referred to as nonradiological workers. The scope of the required radiation safety training for individuals in this category includes the elements of 10 CFR 19.12, AInstructions to workers.@

2) Radiological Worker - A general employee whose job assignment involves operation of radiation-producing devices, who works with radioactive materials, who enters facility radiological areas, or who is likely to be routinely occupationally exposed above 0.1 rem (1 mSv) per year from either internal or external radiation exposures (10 CFR 835).
3) Radiation Protection Technician -Technicians trained and qualified to conduct the day-to-day operation of the radiation protection program. In addition to conducting routine surveillances, RPTs assist facility workers in the radiological aspects of facility work.

The training program for each of the worker categories is commensurate with the depth of knowledge required for the safe conduct of work and the hazards encountered. Specifically, general employees are given a brief overview of radiation protection policies and a sufficient knowledge level of radiological postings and access requirements. Such employees may not enter radiological areas. Radiological workers are given a more detailed level of training such that they can safely conduct hands-on work in the presence of radiological hazards. Technicians who must be RPT-qualified to perform radiological work are provided a high level of technical training in order to accurately characterize radiological conditions and assist in applying the appropriate controls. Training lesson plans and instructor qualifications (*to be developed during Part B)* are addressed in Section 3.4, ATraining and Qualification.@

Facility training for radiation workers includes both classroom and applied training and is verified by examination or skills demonstration. Training is a prerequisite to assignment as a radiological worker or prior to receiving occupational exposure. Retraining for all categories is provided when there is a significant change to radiation protection policies and procedures affecting employees. Each person is requalified periodically, at intervals not to exceed 2 years. Radiation safety training requirements for all facility workers are specified in Table 5-6. In addition, the RPT training program satisfies commercial nuclear industry standards.

Table 5-6. TWRS-P Facility Worker Training Requirements

Facility Area	Training Required for Unescorted Entry
Entry into the facility Controlled Area	General Employee Training (GET)
Entry into Radiation Areas	GET and Radiation Worker Training
Entry into High or Very High Radiation Areas	GET and Radiation Worker

	Training
Entry into Contamination Areas and High Contamination Areas	GET and Radiation Worker Training
Entry into Airborne Radioactivity Areas	GET and Radiation Worker Training

5.6 VENTILATION SYSTEMS{tc \l2 "5.6 VENTILATION SYSTEMS}

The TWRS-P Facility ventilation systems are engineered control features used to confine airborne materials to the designated process areas and to protect facility workers and co-located workers. The facility ventilation system is used to control occupational radiation exposures to levels lower than those identified in Table 5-3. With respect to radiation safety, the process areas have three independent and reliable ventilation systems, and the facility contains five distinct isolation zones providing a graded level of radiation protection for workers. The process areas include the vessel, cell, and facility operating areas.

The graded protection concept requires the area with the greatest radioactive material source term (i.e., vessel) to have the largest negative differential air pressure with respect to both the other facility areas and the atmosphere. This concept ensures air flows from uncontaminated areas toward the most contaminated process areas, avoiding the dispersion of radioactive contamination within the facility. A description of each zone by its classification, the anticipated surface contamination and airborne levels, and examples of typical controls are provided in Table 5-5. All process ventilation air streams are filtered prior to discharge to the atmosphere.

5.7 AIR SAMPLING{tc \l2 "5.7 AIR SAMPLING}

The RPP describes the program for air monitoring and sampling, a key component of facility monitoring. Continuous air monitors (CAMs) are primarily used in areas where an individual is likely to be exposed to airborne radioactivity exceeding the respiratory protection action level, or where there is a need to alert personnel to an unexpected increase in airborne radioactivity levels.

Fixed sampling stations are used, where appropriate, to sample workplace air where an alarming feature is not needed. The data derived from both continuous air monitoring and sampling are used for tracking and trending, to provide information on the effectiveness of contamination control and radiation safety practices, to identify long-term variations in radioactivity levels, and to identify potential opportunities for radiological work practice improvements. Portable sampling equipment may also be used where airborne material may be present in a very limited area or where nonroutine work is conducted. Data collected by portable equipment is typically used to document worker exposure during specific work activities. Finally, breathing zone sampling is used to assess the contamination level in the breathing zone of a worker conducting specific task. These data are typically used to determine actual personnel exposures and to characterize the variability of contaminants over a large work area.

Determination of the need for, location, and type of air sampling or monitoring are guided by Regulatory Guide 8.25, *Air Sampling in the Workplace* (NRC 1992a), and NUREG 1400, *Air Sampling in the Workplace* (NRC 1994). As the definitive design of the facility matures, the precise location(s) of air sampler placement is documented.

5.8 CONTAMINATION CONTROL{tc \l2 "5.8 CONTAMINATION CONTROL}

The radioactive contamination control program ensures that facility contamination sources are limited to those areas of the facility designed to handle radioactive materials and that these areas are as small as reasonably practicable. Contamination control measures include both engineered features and administrative controls. The specific application of these controls is identified and detailed in the RPP. To the extent possible, the applicable portions of Regulatory Guide 8.24, Rev. 1, *Health Physics Surveys during Enriched Uranium-235 Processing and Fuel Fabrication* (NRC 1979), is used in development of the contamination control program.

Examples of some of the engineered features employed to control contamination are facility and local ventilation, high-integrity source containers and confinement systems, liquid spill prevention and confinement, and control of access to process materials. Examples of administrative controls are the monitoring and decontamination programs, facility access controls, use of protective clothing, use of procedures for radiological work, and the worker training and qualification programs.

The radiological monitoring program is designed to document the radiological status of the facility on a routine basis. The type and frequency of monitoring is specified in the RPP and is based on the potential process or personnel hazard and the potential for changes in conditions. The RPP also specifies the action levels and the appropriate responses for out-of-specification conditions identified by the monitoring program.

Facility areas that exceed the surface contamination levels listed in Table 5-2 are identified, posted, and controlled as contamination areas. Areas exceeding 100 times the contamination levels in Table 5-2 are identified, posted, and controlled as high contamination areas. This identification allows controls to be applied in a graded manner so that the specified protection is commensurate with the hazard present. Personnel with skin or clothing contamination exceeding Table 5-2 levels are immediately decontaminated as specified in the RPP.

5.9 EXTERNAL EXPOSURE{tc \l2 "5.9 EXTERNAL EXPOSURE}

The external dosimetry program is administered by the facility Radiation Protection organization as specified in the RPP and are controlled by a set of reviewed and approved procedures. The quality and accuracy of the dosimetry data provide a record of personnel exposures; the data are indicators to measure the effectiveness of controls and whether external exposures are ALARA.

Dosimetry services supply dosimeters, dosimeter processing, reporting, and if needed, consulting services. The dosimetry program is accredited by either the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Bureau of Standards (10 CFR 20) or the DOE Laboratory Accreditation Program (DOELAP) for Personnel Dosimetry (10 CFR 835).

External dosimetry devices monitor the radiation exposure of TWRS-P Facility personnel that incur occupational exposures. Workers who, under typical conditions, are likely to meet one or more of the following criteria are monitored:

1) Individuals who incur an effective dose equivalent to the whole body of 0.1 rem (0.001 Sv) or more in a year

2) Individuals who incur a shallow dose equivalent to the skin or to any extremity of 5 rem (0.05 Sv) or more in a year

3) Individuals who incur a dose equivalent to the lens of the eye of 1.5 rem (0.015 Sv) or more in a year

4) Individuals who incur a deep dose equivalent from external exposures to any organ or tissue, other than the lens of the eye, of 5 rem (0.05 Sv)

5) Declared pregnant workers where the embryo/fetus is likely to receive, from external sources, a dose equivalent in excess of 0.05 rem (0.5 mSv)

6) Minors and members of the public likely to receive, in 1 year, from external sources during direct onsite access, a dose in excess of 0.05 rem (0.5 mSv)

7) Individuals that enter a high or very high radiation area.

The RPP requires that appropriate dosimetry be worn by all persons meeting any of the criteria noted above. Although supervisory personnel have a responsibility to ensure that individuals under their purview are monitored, individual employees are ultimately responsible for ensuring that dosimetry is worn as prescribed in facility training and as specified in the applicable RWP or technical work document.

The performance specification of dosimeters is determined from an assessment of the types and ranges of the radiation present in the process materials and other facility sources. The types of dosimeters required for each facility exposure condition is also assessed and specified by the Radiation Protection Organization on an ongoing basis. In addition to the basic whole body badge, extremity dosimeters and other supplementary dosimeters (e.g., electronic, self-reading, or dosimeter) are specified as appropriate to document and control exposures.

5.10 INTERNAL EXPOSURE{tc \l2 "5.10 INTERNAL EXPOSURE}

The internal dosimetry program is administered by the Radiation Protection Organization as specified in the RPP and controlled by a set of reviewed and approved procedures. The quality and accuracy of the dosimetry data provide a record of personnel exposures and are used as an indicator that controls are effective and internal exposures are ALARA.

The RPP provides the criteria requiring employees to be included in the internal dosimetry program. Internal dosimetry requirements are specified in the applicable RWPs or technical work documents. Internal dosimetry requirements are determined by a documented Radiation

Protection Organization assessment of the internal exposure potential for each specific facility work area or task with which the individuals are involved.

Internal dosimetry services are provided by a qualified vendor. Services are expected to include invivo or invitro measurement (bioassay) of radionuclides. At present, there is no accreditation program for internal dosimetry.

Individuals likely to receive a committed effective dose equivalent (CEDE) of 0.1 rem or greater or 5 rem CEDE to any organ or tissue in a year under normal operating conditions are placed on a routine bioassay schedule (10 CFR 835). The methods selected are based on the types, levels, and potential for intake of radioactive materials present.

5.11 SUMMING INTERNAL AND EXTERNAL EXPOSURE{tc \l2 "5.11 SUMMING INTERNAL AND EXTERNAL EXPOSURE}

The RPP requires that the total effective dose equivalent (TEDE) for an individual be determined by summing that individual's effective dose equivalent from external exposures and the CEDE from internal exposures. Radiation exposures are controlled, and reported to the individuals in TEDE, except where standards specify differently (e.g. extremity and skin dose). Management of exposures and exposure data is consistent with Regulatory Guides 8.7, *Instructions for Recording and Reporting Occupational Radiation Exposure Data* (NRC 1992b), Regulatory Guide 8.34, *Monitoring Criteria and Methods to Calculate Occupational Radiation Doses* (NRC 1992c), and Regulatory Guide 8.36, *Radiation Dose to the Embryo/Fetus* (NRC 1992d).

5.12 RESPIRATORY PROTECTION{tc \l2 "5.12 RESPIRATORY PROTECTION}

Protection of personnel from internal radiation exposures is accomplished in the TWRS-P Facility by engineered features (e.g., confinement, ventilation, and remote handling) that have been designed into the facility. In cases where engineered features are not practical, administrative controls such as procedures, postings, and physical access barriers are used. The least desirable protective feature selected is personal respiratory protection.

The facility operates a respiratory protection program that satisfies the applicable portions of 10 CFR 20 and ANSI Z88.2-1980, *Practices for Respiratory Protection* (ANSI 1980). Only respirators that have been approved by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA) are used.

The respiratory protection program also includes the following:

1) Input from the air sampling and monitoring program to ensure that the correct type(s) of respirators are and were specified and that airborne exposures are documented for alternate exposure assessments (should internal evaluations be deemed inadequate for any reason)

2) Input from the internal dosimetry program to ensure the total worker protection program is effective

3) Medical approval and monitoring program for workers using respiratory protection

4) Periodic respirator fit test and employee respirator training

5) Written program procedures addressing selection, fit, issuance, use, reuse, life expectancy, maintenance, and testing of respirators.

5.13 INSTRUMENTATION{tc \l2 "5.13 INSTRUMENTATION}

Radiation detection and measurement instrumentation are used to implement the personnel radiological monitoring program and to ensure that radiation exposures and contamination are maintained ALARA. A variety of instruments is used for determining exposure rates, measuring surface and personnel contamination, and for measuring air concentrations during both routine and off normal conditions. The RPP establishes the instrumentation use, calibration, and maintenance requirements, in accordance with appropriate American National Standards Institute standards, to ensure the quality and reliability of radiological assessments. Instrument calibrations are conducted with sources traceable to the National Institute of Standards and Technology.

The Radiation Protection organization is responsible for the following activities involving radiological instruments:

1) The specification of instruments to be used according to the type(s), levels, energies of the radiation(s) encountered, and existing environmental conditions

2) Periodic instrument maintenance and calibration

3) Routine instrument operability tests

4) Proper instrument use and application.

5.14 INTEGRATED SAFETY ANALYSIS{tc \l2 "5.14 INTEGRATED SAFETY ANALYSIS}

An integrated safety analysis for radiation protection of both the facility workers and the public is provided in Section 4.0, AIntegrated Safety Analysis.@ The review identifies and evaluates specific engineering or administrative controls for the prevention or mitigation of radiation exposures from the identified accident sequences.

APPENDIX 5A

RADIATION PROTECTION PROGRAM OUTLINE

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1.0 INTRODUCTION

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2.0 RADIATION PROTECTION PROGRAM OVERVIEW

The following describes the work scope to which the radiation protection program (RPP) applies, identifies the regulatory drivers (i.e., 10 CFR 835), and establishes the administrative requirements under which the RPP will function and be maintained. The RPP will implement regulatory and contractual requirements to ensure the radiological safety of all persons who may have access to the facility.

The RPP will be developed and submitted for approval in stages, depending upon the hazard addressed and the applicable regulatory driver(s). For example, the initial RPP will encompass design requirements during the facility design phase. No radiological source term will exist to cause personnel exposures during the design activity. The RPP will be modified to accommodate the potential radiological hazards associated with AP-106 Tank modification activities. Finally, the RPP will be modified again to address the hazards associated with the operational TWRS-P Facility. This outline is primarily oriented towards the full scope of project activities anticipated for the operational phase.

2.1 APPLICABILITY

The scope of work to which this RPP applies will be defined.

<u>Example</u>: *The RPP will be valid for any Tank Waste Remediation System (TWRS-P) Facility radiological work, including decontamination activities within the site boundary and facility modification and final decontamination and decommissioning activities. Work determined to be outside this scope (i.e., a change in facility mission) will not be initiated until the RPP is reviewed, modified as necessary, and the concurrence of the regulator is obtained.*

2.2 PURPOSE

The purpose of the RPP, as well as its underlying regulatory and contractual basis, will be described in this section.

<u>Example</u>: *The RPP is the documented RPP from which all facility operations, maintenance, and Radiological Protection Group (RPG) procedures involving radiological hazards will be developed. It defines the regulatory standards, organization, and methods used to ensure the radiological safety of facility workers and others who may have access to the facility.*

(NOTE: The primary regulatory driver for the RPP is 10 CFR 835, AOccupational Radiation Protection.@ If and when the TWRS-P Facility operation comes under regulation by the U.S. Nuclear Regulatory Commission [NRC], 10 CFR 20, AStandards for Protection Against Radiation,@ will become the primary standard for the facility RPP. All significant differences between the requirements of 10 CFR 835 and 10 CFR 20 have been identified and evaluated with respect to project impacts from the proposed regulatory transition. The final program will be developed to minimize cost and time impacts from such a regulatory transition.)

2.3 RADIATION PROTECTION/ALARA PHILOSOPHY

The corporate radiation protection and as low as reasonably achievable (ALARA) philosophies are documented and discussed in this section. The corporate document guiding development of the TWRS-P Facility ALARA program is *Codes of Practice*, *Application of ALARP to the Routine Radiation Exposure of Workers and the Public* (BNFL 1994). In addition, the applicable portions of PNL-6577, *Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are As Low As Reasonably Achievable (ALARA)* (Munson 1988)**,** and Regulatory Guide 8.10, Revision 1R, *Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable* (NRC 1975), are used to guide development of the ALARA program.

2.4 SUMMARY OF RESPONSIBILITIES AND QUALIFICATIONS

This section documents the RPG responsibilities and the responsibilities and qualifications of key specific positions within the organization. Key positions are considered to be the Radiation Protection Manager, the Facility Analyst or Radiological Engineer, and the Radiation Protection Technician.

2.5 INTERACTION WITH THE CLIENT AND REGULATOR

The relationships and interfaces with the U.S. Department of Energy (DOE) and NRC, as appropriate, pertaining to the RPP are detailed in this section.

2.6 REVIEWS AND AUDITS

The requirements for periodic internal reviews and audits (self-assessments) of the RPP content and implementation will be specified. The RPP will commit to conducting internal audits of all functional elements, including program content and implementation of the program, at an interval not to exceed 3 years. General guidance will also be outlined for RPG personnel responding to external evaluations.

2.7 RADIATION PROTECTION PROGRAM MAINTENANCE

This section describes the process for modifying the RPP to keep current with operations and regulatory changes and to take advantage of performance improvement opportunities as well as lessons learned.

3.0 RADIOLOGICAL STANDARDS

This chapter establishes the program standards for the RPP. Standards will include both regulatory exposure limits, operating administrative control levels, and other standards to identify and control radiological hazards. Subsections of this chapter will address responsibilities, exposure limits and administrative control levels, contamination control levels and release limits, and radiological posting.

3.1 SUMMARY OF RESPONSIBILITIES

This section documents the TWRS-P Facility responsibilities for tracking and maintaining occupational exposure and other program standards within the administrative control levels and regulatory limits.

3.2 EXPOSURE LIMITS AND ADMINISTRATIVE CONTROL LEVELS

This section specifies the exposure limits, administrative control level and other program standards that apply to facility operations. The occupational exposure standards shown in Table 3-1 will be adopted for employees classified as *radiation workers*. In addition, the following radiation exposure standards for the following nonradiation workers will be established: 1) *embryo/fetus* (from the period of conception to birth) - 0.5 rem (0.005 Sv) dose equivalent, 2) *minors* (exposed to radiation or radioactive material during direct onsite access) - 0.1 rem (0.001 Sv) total effective dose equivalent in a year, 3) *members of the public and facility employees that are not radiation workers* (exposed to radiation or radioactive material during direct onsite access) - 0.1 rem (0.001 Sv) total effective dose equivalent in a year.

Table 3-1. Statutory and TWRS-P Facility Annual Administrative Control Levels

Target Organ	Statutory Limits Rem (Sv)	Administrative Control Levels - Rem (Sv)
Total effective dose equivalent	5 (0.05)	1 (0.01)
Summation of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye	50 (0.5)	10 (0.1)
Lens of the eye dose equivalent	15 (0.15)	3 (0.03)
Shallow dose equivalent to the skin or to any extremity.	50 (0.5)	10 (0.1)

3.3 CONTAMINATION CONTROL LEVELS AND RELEASE LIMITS

This section specifies the TWRS-P Facility contamination control levels and radiological release limits. Contamination control activities will be based on the values presented in Table 3-2.

Table 3-2. Surface Radioactivity Values (dpm/100 cm^2)[a]

Nuclide	Removable[b,d]	Total (Fixed+Removable)[b,c]
U-nat, U-235, U-238, and associated decay products	1,000	5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.[e]	1,000	5,000

a The values in this appendix apply to radioactive contamination deposited on, but not incorporated into the interior of, the contaminated item. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides apply independently. All values are in units of disintegrations per minute (dpm). Becquerels may be obtained by dividing the dpm by 60.

b As used in this table, dpm means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c The levels may be averaged over 1 m^2 provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the activity guide G if: 1) from measurements of a representative number n of sections it is determined that where S_i is the dpm/100 cm^2 determined from measurement of Section I; or 2) it is determined that $1/n\ Ó_n S_i\ \$\ G$, where S_i the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds 3G.

d The amount of removable radioactive material per 100 cm^2 of surface area will be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area will be based on the actual area and the entire surface will be wiped. Except for transuranics and Ra-228, Ac-227, Th-228, Th-230, Pa-231, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

e This category of radionuclides includes mixed fission products, including the Sr-90 that is present in them. It does not apply to Sr-90, which has been separated from the other fission products.

3.4 RADIOLOGICAL POSTING

This section specifies the posting requirements for identification of radiological hazards and the posting of entry and exit requirement information. The TWRS-P radiological area postings will adhere to the criteria in Table 3-3. In addition, radiological controlled areas will be used as a transition area between radiological areas and unrestricted areas within the site boundary. Access to these areas is managed to protect individuals from exposure to radiation or radioactive material. Individuals entering only controlled areas without entering radiological areas are not expected to receive a total effective dose equivalent exceeding 0.1 rem (0.001 Sv) in a year.

Table 3-3. TWRS-P Radiological Posting Criteria

Radiological/Controlled Areas	Criterion
Airborne Radioactivity Area	Any TWRS-P Facility area where the measured concentration of airborne radioactivity above natural background exceeds or is likely to exceed 10 % of the derived air concentration (DAC) values listed in 10 CFR 835, or where an individual could receive a weekly exposure in excess of 12 DAC-h.
Contamination Area	Any area where surface contamination levels are greater than the values specified in Table 3-2 of this chapter, but less than or equal of 100 times those levels.
Controlled Area	Any area, inside the site boundary, access to which is limited by the TWRS-P Facility. Individuals who enter only controlled areas without entering radiological areas are not expected to receive a total effective dose equivalent of more than 0.1 rem (0.001 sievert) in one year.
High Contamination Area	Any area where surface contamination levels are greater than 100 times the values specified in Table 3-2 of this chapter.
High Radiation Area	Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (0.001 Sv) in 1 h at 30 cm from the radiation source or from any surface that the radiation penetrates.
Radiation Area	Any area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 h at 30 cm from the source or from any surface that the radiation penetrates.
Very High Radiation Area	Any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 h at 1 m from a radiation source or from any surface that the radiation penetrates.

Maintenance of occupational exposures and controls over contamination and other sources of radiation exposure in accordance with standards identified in this section will ensure the radiological safety of TWRS-P Facility workers, co-located workers, the public, and the environment.

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4.0 CONDUCT OF RADIOLOGICAL WORK

This section discusses the recommended and required controls to be used in the performance of radiological work to ensure the radiological safety of TWRS-P Facility workers, co-located workers, the public, and the environment. The specified controls will be minimum requirements and are not intended to exclude other additional controls approved by the RPG. Subsections of this chapter will address responsibilities, planning and preparation for radiological work, entry and exit requirements, radiological work controls, and performance evaluation.

4.1 RESPONSIBILITIES

This section assigns responsibilities for implementing the provisions of the RPP in the conduct of radiological work and for ensuring adherence to the radiological standards described in Chapter 3.0.

4.2 PLANNING AND PREPARATION FOR RADIOLOGICAL WORK

This section establishes the planning and preparation requirements for radiological work. All work involving radiation exposures within the TWRS-P Facility will include technical review and input by the RPG. A graded approach for radiological work planning activities will be used, depending upon the projected personnel exposures involved or the risk associated with the tasks. In cases involving significant occupational exposures, the review requirements will be more stringent and practice runs with mockups may be required.

4.3 ENTRY AND EXIT REQUIREMENTS

This section establishes the entry and exit requirements for TWRS-P Facility radiological areas. Examples of entry requirements include ensuring that the work scope of the entry is covered by an RWP, protective clothing requirements are satisfied, training and other qualifications are met, dosimetry is adequate, personnel have read and understand the RWP requirements, and special instructions are satisfied. Exit requirements are also specified on the RWP and may include conducting personnel contamination surveys, removing protective clothing at the designated location, and washing, as appropriate.

4.4 RADIOLOGICAL WORK CONTROLS

This section specifies the work controls and techniques that are recommended and mandatory (*should* and *shall* be used) for work in radiological areas. A large number of work controls may be employed to control exposures. These controls include the use of special time-saving and remote-handling devices, protective equipment, contamination control devices, zones, hazards isolation, exposure times limitations, and worksite preparation.

4.5 EVALUATION OF PERFORMANCE

This section details the self-evaluation methods and criteria that will be used to assess the effectiveness of work control activities.

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5.0 RADIOACTIVE MATERIALS AND RADIATION GENERATING DEVICES

The controls that will be applied to work involving use of radioactive materials and radiation- generating devices are specified in this chapter. The specified controls will be minimum requirements and are not intended to exclude other types of controls approved by the RPG. The specified controls for work with radioactive materials and radiation-generating devices will ensure that such work is conducted in a manner that ensures the radiological safety of facility workers, co-located workers, the public, and the environment. Subsections of this chapter will address responsibilities; radioactive material identification, storage, and control; release and transportation of radioactive material; radioactive source control; solid radioactive waste management; control of radioactive liquids and airborne radioactivity; radiation-generating devices; and support activities.

5.1 RESPONSIBILITIES

This section documents the facility responsibilities for control of, access to, and use of radioactive materials and radiation-generating devices.

5.2 RADIOACTIVE MATERIAL IDENTIFICATION, STORAGE, AND CONTROL

This section specifies requirements for identification, storage, use, and control of process radioactive materials.

5.3 RELEASE AND TRANSPORTATION OF RADIOACTIVE MATERIAL

This section specifies the requirements for the release and preparation for transport of radioactive materials. Requirements will include contamination release levels, exposure rate limitations, packaging, and the documentation required to be generated and maintained.

5.4 RADIOACTIVE SOURCE CONTROL

This section specifies the requirements for controlling radioactive sources, primarily the identification, storage, use, inventory, and control of radioactive materials other than process materials.

5.5 SOLID RADIOACTIVE WASTE MANAGEMENT

This section specifies the radiological protection aspects of solid radioactive waste management. Included are requirements for the generation, preparation, storage, documentation, and shipment or disposal of radioactive wastes.

5.6 CONTROL OF RADIOACTIVE LIQUIDS AND AIRBORNE RADIOACTIVITY

This section specifies the radiological protection aspects of radioactive liquids and airborne materials. Included are requirements for the generation, preparation and treatment, storage, documentation, and disposition of radioactive wastes.

5.7 RADIATION-GENERATING DEVICES

This section specifies the requirements for control and use of radiation-generating devices. Controls are applicable to portable and fixed facility devices as well as for vendor devices used within the TWRS-P Facility site boundary.

5.8 SUPPORT ACTIVITIES

This section will address the requirements for radiological support functions such as protective clothing and equipment, laundry, decontamination, contaminated area vacuum cleaners, and portable air-handling equipment.

6.0 RADIOLOGICAL PROTECTION SUPPORT

The RPP-specified support functions will help ensure that facility design and radiological controls are effective for routine radiological conditions, that the reliability and accuracy of radiological measurements meet requirements and are maintained, and that response to nonroutine radiological conditions is prompt and appropriate. In addition, these RPP support functions help ensure that facility operations are conducted within applicable radiological standards, limits, and administrative control levels. Subsections of this chapter will address responsibilities, external dosimetry, internal dosimetry, respiratory protection, radiological monitoring and surveys, instrumentation and calibration, and radiological contingencies.

6.1 RESPONSIBILITIES

This section documents the RPG responsibilities for various radiological protection support activities.

6.2 EXTERNAL DOSIMETRY

This section documents the external dosimetry requirements. It includes criteria for individuals to be monitored; the use, storage and care of dosimetry; review of dosimetry results; and response to out-of-specification readings.

6.3 INTERNAL DOSIMETRY

This section documents the internal dosimetry requirements. It includes criteria for individuals to be monitored, specifics on sampling and in-vivo counting, review of dosimetry results, and response to out-of-specification readings.

6.4 RESPIRATORY PROTECTION

This section documents the TWRS-P Facility respiratory protection requirements. The requirements will pertain to medical clearance, respirator fit testing, and respirator selection, issuance, use, and maintenance.

6.5 RADIOLOGICAL MONITORING AND SURVEYS

This section specifies the radiological monitoring and survey requirements. The content will include routine surveillance frequencies, the types of surveys to be performed, responses to out-of-specification conditions, and general guidance for performing special monitoring and surveillance.

6.6 INSTRUMENTATION AND CALIBRATION

This section specifies the radiological instrument calibration and maintenance requirements. In addition to periodic instrument calibration, equipment will be performance-checked periodically to ensure adequate battery level, proper response to radiation fields, and measurement within predetermined performance specifications.

6.7 RADIOLOGICAL CONTINGENCIES

This section discusses provisions for dealing with radiological contingencies such as radioactive material releases and personnel contamination events.

7.0 TRAINING AND QUALIFICATIONS

This section will specify training and qualification requirements to ensure that personnel working in the facility can recognize radiological hazards; understand the entry, exit, and work requirements; and implement the radiation protection and personnel protection controls specified in the appropriate work document(s). Subsections of this chapter will address responsibilities, general employee radiological training, radiological worker training, radiological protection technician (RPT) qualification, and other radiological training. This training will highlight features of the facility intended for protection of the worker and the public (e.g., seismic design, shielding, interlocks, vessel integrity and labeling.

7.1 RESPONSIBILITIES

This section documents the responsibilities for the worker training and qualification program.

7.2 GENERAL EMPLOYEE RADIOLOGICAL TRAINING

This section specifies the radiological safety training requirements for all TWRS-P Facility employees.

7.3 RADIOLOGICAL WORKER TRAINING

This section specifies the radiological safety training requirements for radiological workers. This training is required for employees having access to or working with radioactive materials, personnel entering TWRS-P Facility radiological areas, or workers that require monitoring under Sections 6.2 and 6.3 of the RPP.

7.4 RADIOLOGICAL PROTECTION TECHNICIAN (RPT) QUALIFICATION

This section specifies the radiological safety training and qualification requirements for RPTs. This group requires a higher level of operational training as they are responsible for measuring and posting the TWRS-P Facility radiological environment, applying radiological controls in the workplace, and providing workplace guidance in maintaining exposures ALARA. Commercial nuclear industry training standards will be adopted to ensure the appropriate level of knowledge and qualification.

7.5 OTHER RADIOLOGICAL TRAINING

This section specifies the radiological safety training requirements for other workers whose activities may affect radiological work within the TWRS-P Facility or who may require facility access.

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8.0 RADIOLOGICAL RECORDS

This chapter specifies the program requirements for the generation, review, storage, and disposition of radiological program records in accordance with regulatory requirements and other standards. Radiological records include, but are not limited to, dosimetry, instrument maintenance, survey, monitoring, and procedure records. Subsections of this chapter will address responsibilities, requirements, radiological protection procedures, radiological survey records, instrumentation and calibration records, records management, and radiological reporting.

8.1 RESPONSIBILITIES

This section documents the responsibilities for generating and maintaining the radiological records program.

8.2 REQUIREMENTS

This section establishes the radiological records requirements for assigned employees, temporary workers, and visitors.

8.3 RADIOLOGICAL PROTECTION PROCEDURES

This section establishes the records requirements for RPP procedures.

8.4 RADIOLOGICAL SURVEY RECORDS

This section provides requirements for generating and maintaining facility radiological survey records.

8.5 INSTRUMENTATION AND CALIBRATION RECORDS

This section provides requirements for generating and maintaining radiological instrument and calibration records.

8.6 RECORDS MANAGEMENT

This section establishes the requirements for systems and procedures to manage the maintenance, collection, storage, and disposition of RPP records.

8.7 RADIOLOGICAL REPORTING

This section establishes radiological reporting criteria and specifies the necessary reporting administrative systems and procedures. The requirement for annual reporting of occupational exposures to individuals and to regulators will be addressed in this section. Reporting will also include both internal and external reporting requirements for such items as significant radioactive material releases or exceeding a radiation exposure standard.

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9.0 APPENDICES

Appendices may be used to include a number of different types of information that supplement what is provided in the main body of the RPP plan. As a minimum, appendices containing an acronym list and definitions of terms are anticipated.

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APPENDIX 5B

ENVIRONMENTAL RADIATION PROTECTION PROGRAM OUTLINE

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1.0 INTRODUCTION

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2.0 ENVIRONMENTAL RADIATION PROTECTION PROGRAM OVERVIEW

This chapter will describe the Tank Waste Remediation System-Privatization (TWRS-P) Facility workscope to which the Environmental Radiation Protection Program (ERPP) applies, identify the regulatory drivers, and define the administrative requirements under which the ERPP will function and be maintained. The ERPP will implement regulatory and contractual requirements to ensure the radiological safety of the public and the environment.

2.1 APPLICABILITY

The scope of work to which this ERPP applies will be defined.

Example: The ERPP will be valid for the scope of radiological work to be performed within the TWRS-P Facility, including decontamination activities within the TWRS-P Facility site boundary and facility modification and deactivation activities. Work determined to be outside this scope (i.e. a change in facility mission) will not be initiated until the ERPP is reviewed, modified as necessary, and the concurrence of the regulator(s) obtained.

2.2 PURPOSE OF THE ENVIRONMENTAL RADIATION PROTECTION PROGRAM

The purpose of the ERPP, as well as its underlying regulatory and contractual basis, will be described in this section.

Example: The ERPP controls all required activities to protect the environment and the public from TWRS-P radioactive emissions. It defines the regulatory standards, organization, controls, methods, and reporting requirements used to ensure the radiological safety of the public and the environment.

Regulatory drivers for the ERPP will include applicable portions of the following regulations:

1) *Washington State Administrative Code*, Titles 173 and 246

2) 40 CFR 61 and 40 CFR 191

3) 10 CFR 20, “Standards for Protection Against Radiation,” and 10 CFR 835, “Occupational Radiation Protection.”

2.3 DEVELOPMENT OF THE ENVIRONMENTAL RADIATION PROTECTION PROGRAM

The scope, specificity, and content of the ERPP will be developed and maintained on a graded approach that is commensurate with the potential hazard posed by the facility source terms and processes. The TWRS-P Facility hazard assessment will be the primary source document characterizing the facility hazard potential.

2.4 ENVIRONMENTAL RADIATION PROTECTION AND ALARA PHILOSOPHY

The BNFL corporate radiation protection and as low as reasonable achievable (ALARA) philosophies, as applied to the protection of the environment, are to be documented and discussed in this section.

2.5 ENVIRONMENTAL RADIATION PROTECTION PROGRAM ORGANIZATION AND FACILITY INTERFACE

The responsible Environmental Protection Group (EPG) will be described here including an organizational chart and descriptions of key positions. The interfaces between this organization and other facility organizations will also be identified.

2.6 SUMMARY OF RESPONSIBILITIES

This section will document the EPG responsibilities and the responsibilities of specific EPG positions, including the responsibility for managing the program and for collecting, analyzing, and integrating environmental monitoring data and the generation of an annual report.

2.7 INTERACTION WITH THE CUSTOMER, THE REGULATOR, AND OTHERS

The relationships and interfaces with the U.S. Department of Energy (DOE) and regulators will be detailed here, as well as the interface descriptions pertaining to the Hanford Site environmental protection program.

2.8 REVIEWS AND AUDITS

The requirements for periodic internal reviews and audits of the ERPP content and implementation will be specified. Brief guidelines for interacting with regulatory agencies during onsite assessments will be included.

2.9 ENVIRONMENTAL RADIATION PROTECTION PROGRAM MAINTENANCE

This section will describe the process for modifying the ERPP to keep current with regulatory changes, facility modifications, and to take advantage of performance improvement opportunities.

3.0 RADIOLOGICAL STANDARDS

This chapter will establish the program standards for the ERPP. Maintenance of radiation exposures to the public in accordance with standards identified in this section will ensure the radiological safety of the public and the environment. In addition, the monitoring and assessment criteria for determining impacts from TWRS-P Facility effluents will allow demonstration of compliance to these standards. Subsections of this chapter will address exposure limits and administrative control levels, monitoring criteria, and assessment models and methods of monitoring. *(Note: Contract requirements call for compliance to 10 CFR 834, AEnvironmental Protection,@ which was a draft at the time of contract signing. At last review, the final issuance of 10 CFR 834 will probably be delayed past the required ERPP delivery date. Fortunately, all 10 CFR 834 standards are duplicated in other regulations that may be applicable, if the original TWRS-P regulator were not the DOE. All environmental protection standards adopted in this document are equivalent to the 10 CFR 834 requirements. Therefore, this plan should be in compliance with any future issuance of a 10 CFR environmental protection standard.)*

3.1 EXPOSURE LIMITS AND ADMINISTRATIVE CONTROL LEVELS

This section will specify the exposure limits, administrative control levels, and other program standards that apply to facility operations. The exposure standards for the associated target organs for members of the public shown in Table 3-1 will be adopted.

3.2 MONITORING CRITERIA

This section specifies the criteria for required monitoring of effluent points and other areas, including onsite and offsite locations.

3.3 ASSESSMENT MODELS AND METHODS OF MONITORING

The models used to calculate public exposures and the monitoring methods used to demonstrate compliance with the exposure standards will be described in this section. Model descriptions will include discussion and justification of bioaccumulation and dose-conversion factors.

Table 3-1. TWRS-P Facility Statutory Exposure Standards Applicable to the Public

Regulatory Reference	Target Organ	Statutory Limit
10 CFR 20.1301	Whole Body	0.1 rem/yr Total Effective Dose Equivalent (TEDE) from all sources (dose rate limit of 2 mrem/h)
10 CFR 20.1301, 835.207, and 835.208	Whole Body	0.1 rem/yr TEDE (to public from access to TWRS-P Facility controlled area)
40 CFR 191.03	Whole Body	0.025 rem/yr dose equivalent (DE) (waste management activities)
40 CFR 191.03	Thyroid	0.075 rem/yr DE (waste management activities)
40 CFR 191.03	All Other Critical Organs	0.025 rem/yr DE (waste management activities)
40 CFR 191.04	Whole Body	0.1 rem/yr DE
40 CFR 61.92	Whole Body	0.01 rem/yr effective dose equivalent (EDE)
40 CFR 61.102	Whole Body	0.01 rem/yr EDE 3 mrem/yr EDE (from iodines)
WAC 173-480-040 and WAC 246-247-040	Whole Body	0.025 rem/yr accumulated dose equivalent
WAC 173-480-040 and WAC 246-247-040	Critical Organ	0.075 rem/yr accumulated dose equivalent

4.0 FACILITY SOURCE TERMS, EFFLUENT CHARACTERISTICS, AND CONTROL AND MONITORING FEATURES

The radioactive materials within the TWRS-P Facility with the potential for environmental impact will be identified as well as the potential pathways to the environment and the controls employed to monitor, assess, and mitigate releases. This section addresses facility source terms; effluent characteristics and pathways; potential and projected impacts to the public and the environment; provisions for environmental protection, effluent monitoring, and environmental surveillances; and preoperational evaluation.

4.1 FACILITY SOURCE TERMS

The radioactive materials in the TWRS-P Facility that could cause exposure to the public or to the environment will be described with respect to quantities, physical and chemical properties, location within the facility, and possible release mechanisms.

4.2 EFFLUENT CHARACTERISTICS AND PATHWAYS

The pathways for radioactive materials to be released from the TWRS-P Facility into the environment will be identified and discussed. The anticipated characteristics of the effluents will be described. The pathways will include both intended and potential unintended release pathways, as well as airborne, liquid, and other waste streams.

4.3 POTENTIAL AND PROJECTED IMPACTS TO THE PUBLIC AND TO THE ENVIRONMENT

Projections of both the potential and the expected exposure impacts from the postulated source terms will be presented. Potential impacts are those that would present a worst-case release scenario with no mitigation credit for engineered or administrative controls. Projected impacts are those that are expected during normal process operations with normal operation of effluent control features.

4.4 PROVISIONS FOR ENVIRONMENTAL PROTECTION

The engineered (passive and active) and the administrative controls used to prevent or mitigate releases to the environment will be discussed. In addition, the key TWRS-P Facility features that protect the air, soil, and groundwater will be discussed in this section.

4.5 PROVISIONS FOR EFFLUENT MONITORING

The equipment and methods for monitoring TWRS-P Facility effluents will be generally described in this section. Each designated effluent stream or similar types of streams will be addressed. In addition, the provisions for meteorological data acquisition will be discussed. Meteorological data will be used to characterize the climatic and weather conditions that affect the human and environmental impact determination from TWRS-P Facility effluents.

4.6 PROVISIONS FOR ENVIRONMENTAL SURVEILLANCE

The strategy and plan for sampling and monitoring environmental media, including the sampling frequency, will be presented in this section. Data from this surveillance activity will be used to characterize the location and magnitude of radionuclides in the environment; verify the adequacy of TWRS-P Facility monitoring, modeling, and pathway assumptions; and document the distribution of members of the public in the environment.

4.7 PREOPERATIONAL EVALUATION

This section will describe the TWRS-P Facility activities to conduct and document a preoperational study. This study will begin at least one year prior to introducing radioactive feed into the TWRS-P Facility. The study will be used to establish background and baseline radiation levels, characterize pertinent environmental and ecological parameters, and verify potential pathways for human exposure or environmental impacts.

5.0 ENVIRONMENTAL RADIATION PROTECTION PROGRAM OPERATION

This section will specify the program requirements necessary for the efficient and reliable implementation of the ERPP. Examples are requirements for program procedures, periodic generation and review of data, record keeping requirements, and program assessments.

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6.0 REPORTING OF ENVIRONMENTAL DATA

This section will document the TWRS-P Facility responsibilities for the preparation and issuance of an annual environmental report. Also included will be the documentation requirements for demonstrating program compliance and the reporting requirements for radiological release incidents.

6.1 ANNUAL REPORTS

This section will describe the program requirements for the preparation, review, and issuance of the TWRS-P Facility annual environmental report.

6.2 REPORTS AND DOCUMENTATION DEMONSTRATING COMPLIANCE

This section will describe the required documentation needed to demonstrate compliance to the exposure standards of Chapter 3.0.

6.3 NOTIFICATION AND REPORTING OF INCIDENTS AND ACCIDENTS

This section will describe the notification and reporting requirements with respect to incidents and accidental releases.

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7.0 SOLID RADIOACTIVE WASTE MANAGEMENT

The solid radioactive waste management program features that contribute to protection of the public and of the environment will be presented in this section. Components will include the generation, collection, characterization, storage, treatment, and disposition of facility-generated radioactive wastes. This will be a summary of the controls described in the TWRS-P Facility Solid Waste Management Program.

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8.0 PROPERTY/EQUIPMENT CONTAINING RESIDUAL RADIOACTIVE MATERIALS

The standards, controls, and TWRS-P Facility features applied to equipment, material, and real property containing residual radioactive contamination will ensure protection of the public and the environment when released from TWRS-P Facility radiological controls.

8.1 STANDARDS FOR THE UNRESTRICTED RELEASE OF MATERIALS, EQUIPMENT, AND REAL PROPERTY FROM RADIOLOGICAL CONTROLS

The standards for the unrestricted release of TWRS-P Facility materials, equipment, and real property from radiological controls will be addressed in this section.

8.2 UNRESTRICTED RELEASE OF MATERIALS AND EQUIPMENT FROM RADIOLOGICAL CONTROLS

This section will describe the features and controls that prevent the unrestricted release of contaminated material and equipment from the TWRS-P Facility. This will be a summary of the controls described in the RPP.

8.3 UNRESTRICTED RELEASE OF REAL PROPERTY FROM RADIOLOGICAL CONTROLS

This section will describe the features and controls that prevent the unrestricted release of contaminated TWRS-P Facility real property.

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9.0 APPENDICES

Appendices may be used to include different types of information to supplement chapters of the ERPP.

6.0 NUCLEAR CRITICALITY SAFETY{tc \l1 "6.0 NUCLEAR CRITICALITY SAFETY}

Nuclear Criticality Safety (NCS) evaluations for all areas of the Tank Waste Remediation System-Prioritization (TWRS-P) Facility are performed, reviewed, and will be reported as part of the *Safety Analysis Report* (BNFL 1998) (SAR) process. These evaluations ensure that before the start of operations with fissile material, the entire process is demonstrated to be safely subcritical under both normal and credible off-normal conditions.

6.1 NCS TECHNICAL PRACTICES{tc \l2 "6.1 NCS TECHNICAL PRACTICES}

The TWRS-P Facility is currently in the conceptual design stage. As the design evolves, detailed criticality safety evaluations are performed and independently reviewed by competent analysts. These evaluations document the criticality safety of the facility and the application of the double contingency principle to ensure that the analyzed conditions remain safely subcritical.

6.1.1 Process Analysis From The Integrated Safety Analysis (ISA){tc \l3 "6.1.1 Process Analysis From The Integrated Safety Analysis (ISA)}

Processes and areas within the facility where the potential for criticality exists were identified in the Hazards and Operability Analysis (HAZOP) program as documented in the *Hazard Analysis Report* (BNFL 1997d). Experienced criticality assessors also used checklists of contingencies that have been developed over many years of criticality safety assessment within BNFL. This information was considered in the TWRS-P Project preliminary criticality safety evaluation described in the following section.

6.1.2 NCS Evaluations{tc \l3 "6.1.2 NCS Evaluations}

Preliminary Criticality Safety Statement for TWRS (BEL 1997) presents the preliminary NCS evaluation performed for the conceptual design phase of the TWRS-P Facility. This preliminary assessment covered areas of the facility where potential for criticality exists during both normal and credible off-normal contingency conditions. A highly conservative bounding case was used to give confidence in the criticality safety of this facility. This assessment is described below.

The waste processed in the TWRS-P Facility may contain significant quantities of fissile material. Although more than a critical mass could be present, the fissile material is dilute and homogeneously distributed. As a consequence, the approach taken was to evaluate the maximum fissile material concentration under both normal and contingency conditions to determine whether a significant fraction of the minimum critical concentration could be reached.

Preliminary Criticality Safety Statement for TWRS (BEL 1997) evaluation is based on the fissile material contained in a worst-case batch of high-level waste (HLW) (Envelope D). To ensure conservatism, the evaluation assumed that all plutonium present is Pu-239, further permission was answered by treating all of the U-235 present as Pu-239. This gave an effective Pu-239 concentration of 0.19 g/l. Concentration of the waste through filtration, precipitation, or other processes was examined and, for normal operation, a factor of 3 (from ultrafiltration) was considered bounding. This assumption gave a worst-case Pu-239 concentration of about 0.6 g/l.

For Pu-239 in a homogeneous aqueous solution, the minimum critical concentration is 7.8 g/l (Carter 1969). Using 75% of this value as the safe concentration yields 5.85 g/l of Pu-239. Consequently, for normal operation, there is an order of magnitude safety margin between the maximum fissile concentration and the safe concentration.

At this conceptual stage of the design, no credible off-normal conditions were explicitly identified that could further concentrate the fissile material beyond the threefold increase from ultrafiltration. However, to assess unknown contingencies, it was conservatively assumed that the material being processed was more similar (neutronically) to soil than to an aqueous solution. For Pu-239 in soil, the minimum critical concentration is 1.75 g/l (Clayton 1979). Applying the 75% value, this yields a safe concentration of 1.3 g/l, which is still a factor of 2 higher than the maximum expected fissile concentration. Considering the conservative assumptions used for determining the fissile material concentration, and the level of dewatering anticipated as part of the process, it is judged that an adequate degree of safety exists.

In summary, under both normal operation and contingency conditions, only a fraction of the minimum critical concentration of fissile material can be reached. Therefore, the infinite multiplication factor (k-infinity) will always be less than unity, and no amount of the waste can be made critical. This conclusion will be reevaluated as the design evolves; however, at this time, the only potential NCS controls are related to ensuring that the fissile material concentration in the incoming waste does not exceed specifications.

It should be noted that low-activity waste (LAW) feeds (Envelopes A, B and C) have not been considered explicitly at this stage, because the HLW feed (Envelope D) is considered based on analytical data and defined by the contract to be the limiting case in terms of fissile quantities and concentration. Criticality evaluations for LAW streams will be considered further during the production of the final criticality safety case. Included in this evaluation will be removal of transuranic (TRU) elements, their storage, and subsequent blending with the HLW stream.

6.1.3 NCS Limits{tc \l3 "6.1.3 NCS Limits}

Because of the large quantities of waste present at any given time in the TWRS-P Facility, total quantities of fissile material passing through the facility could constitute more than a critical mass. Most of the fissile material in the incoming and outgoing waste streams; however, is dispersed throughout large volumes of the waste resulting in a low concentration of fissile material in the process at any one time. These low concentrations reduce the likelihood of a criticality.

The NCS evaluation summarized in Section 6.1.2 demonstrates adequate levels of criticality safety margin for normal and credible off normal conditions based on comparisons of the maximum credible fissile concentrations of the waste with safe concentrations (defined as 75% of the minimum critical concentrations).

As the design progresses, the need for criticality limits and criticality safety features will be evaluated. These will be employed if required to ensure subcriticality and to demonstrate compliance with the double contingency principle for criticality safety.

6.1.4 Validation and Use of Analytical Methods{tc \l3 "6.1.4 Validation and Use of Analytical Methods}

If additional NCS limits are identified by reference to experimental data or by validated calculational techniques, the limit will be verified in accordance with Section 4.3, AValidation of a Calculational Method,@ *American National Standard Administrative Practices for Nuclear Criticality Safety* (ANSI/ANS 1983).

6.1.5 NCS Control Methods{tc \l3 "6.1.5 NCS Control Methods}

As noted in Section 6.1.2, the only criticality constraints deemed likely at this time are those related to the incoming waste material. The sampling of this incoming waste is addressed in Interface Control Document (ICD) 19 for LAW feed and ICD 20 for HLW feed to TWRS-P, which provide controls to ensure that fissile material concentration remains within specification. These controls are described as follows.

Before transfer (which is under BNFL Inc. control) of any batch of feed to the BNFL TWRS-P Facility the following is to occur:

1) The U.S. Department of Energy (DOE) takes a representative sample of the batch. DOE demonstrates that the sample taken is representative of the batch.

2) DOE performs analyses on the sample to ensure material specification compatibility (e.g., fissile content is within contract specifications).

3) BNFL reviews and accepts or rejects the DOE analytical results. This acceptance or rejection would be based on BNFL's own confirmatory analysis.

4) DOE initiates batch transfer to the BNFL facility based on established procedures.

As the design evolves, specific constraints related to the incoming waste will be developed as appropriate. These may include such things as redundant, independent samples, in-line monitoring devices with alarms and interlocks, and administrative controls that regulate the movement of waste into the facility.

The following sections describe criticality control methods as applied to the TWRS-P Facility.

6.1.5.1 Mass. The NCS evaluation summarized in Section 6.1.2 demonstrates that criticality safety can be maintained without reliance on fissile mass controls.

6.1.5.2 Favorable Geometry. The NCS evaluation summarized in Section 6.1.2 demonstrates k-infinity is less than unity throughout the facility. Therefore, the TWRS-P Facility requires no geometry controls to ensure criticality safety based on the waste feed specifications in the contract.

6.1.5.3 Density. The NCS evaluation summarized in Section 6.1.2 demonstrates that criticality safety can be maintained without taking credit for density as a NCS control.

6.1.5.4 Enrichment. The NCS evaluation summarized in Section 6.1.2 demonstrates adequate criticality safety based on the assumptions that the plutonium present is 100% Pu-239 and that the U-235 enrichment is 1%. This has been shown to be conservative when compared to the TWRS-P contract feed specification and with tank characterization data. It is recognized, however, that uranium enrichment over 2% U-235 has been processed at the Hanford Site. Because the total quantities of such material are small, the 1% assumption is considered acceptable.

Acceptance of feed streams into the TWRS-P Facility will be subject to strict control, as set out in TWRS-P ICDs 19 and 20. Any proposed feed with an enrichment higher than that assumed in the criticality evaluation, will be subject to reassessment on a case-by-case basis. Out-of-specification feeds with respect to the fissile material content will be accepted only following satisfactory demonstration of criticality safety.

6.1.5.5 Reflection. The NCS evaluation summarized in Section 6.1.2 demonstrates adequate criticality safety based on an infinite geometry. There are no credible conditions at the TWRS-P Facility where a reflector could be more reactive than the material being evaluated. The TWRS-P Facility places no reliance on reflection conditions as a criticality control parameter.

6.1.5.6 Moderation. The NCS evaluation summarized in Section 6.1.2 demonstrates adequate criticality safety by comparing the expected fissile concentrations to minimum critical values. Because these values are minimums, any change in moderation will increase calculated safety margins. Therefore, the TWRS-P Facility places no reliance on moderation as a criticality control parameter.

6.1.5.7 Concentration. The NCS evaluation summarized in Section 6.1.2 demonstrates adequate criticality safety based on the maximum fissile concentration of the feed stream as defined in the TWRS-P Project contract specification. For areas and processes within the facility, the criticality safety of material as specified in the contract has been demonstrated for normal operations and credible off-normal conditions. Therefore, at this stage of design, fissile material concentration within the TWRS-P Facility is not used as a means of criticality control. If future design evolution shows that overconcentration in process vessels (beyond what is assumed in the analysis) is credible, concentration control may become a means of ensuring subcriticality.

Acceptance of feed streams into the TWRS-P Facility will be subject to strict control, as set out in TWRS-P ICDs 19 and 20.

6.1.5.8 Neutron Interaction. The NCS evaluation summarized in Section 6.1.2 demonstrates adequate criticality safety based on a worst-case, infinite geometry. Therefore, the TWRS-P Facility requires no controls on neutron interaction to ensure criticality safety.

6.1.5.9 Neutron Absorber. The NCS evaluation summarized in Section 6.1.2 demonstrates that criticality safety can be maintained without taking credit for neutron absorbers as a NCS control.

6.1.5.10 Volume. The NCS evaluation summarized in Section 6.1.2 demonstrates adequate criticality safety based on a worst-case, infinite geometry. Therefore, the TWRS-P Facility places no reliance on volume as a criticality control parameter.

6.1.5.11 Utilizing Process Variable(s) for Criticality Control. The TWRS-P Facility places no reliance on process variables as a criticality control. The NCS evaluation summarized in Section 6.1.2 demonstrates that adequate criticality safety can be maintained for normal operations and credible off-normal conditions. If future design evolution shows that overconcentration in process vessels (beyond what is assumed in the analysis) is credible, control of process variables may become a means of ensuring subcriticality.

6.1.5.12 Utilizing Instrumentation for Criticality Control. The NCS evaluation summarized in Section 6.1.2 demonstrates that criticality safety can be maintained without the use of instruments as a criticality control. This has been demonstrated for normal operations and credible off-normal conditions. If future design evolution shows that overconcentration in process vessels (beyond what is assumed in the analysis) is credible, instrumentation may become a means of ensuring subcriticality.

6.1.5.13 Summary of Criticality Control. In summary, examination of the variables that may present the potential for criticality against the conceptual design has shown that a criticality event is not considered credible. This applies both to feed import and facility operations.

For feed import, the variables that present the potential for criticality, (e.g., mass, enrichment, and concentration) are functions of the material specification. Therefore, variables of control with respect to feed import into the facility will constitute criticality control. Such control is specified in ICDS 19 and 20 for the import of HLW and LAW material into TWRS-P Facility. Independent actions by both the DOE and BNFL Inc., ensure that the material specification will meet the requirements of the criticality assessment before import to the facility.

Examination of the variables has shown that nothing within the proposed facility process (conceptual design) can present a significant potential for criticality. For normal and credible off-normal (contingency) conditions, subcritical conditions are maintained with wide margins of safety. If further design evaluation shows that credible changes in process variables pose a significant criticality potential, suitable criticality controls will be proposed, evaluated by suitably experienced and qualified personnel, and implemented.

6.1.6 Criticality Accident Alarm System{tc \l3 "6.1.6 Criticality Accident Alarm System}

Item 3 of Safety Criteria 3.3-6 of the TWRS-P Project *Safety Requirements Document* (SRD), (BNFL 1997g) states that neither a Criticality Accident Alarm System (CAS) nor a Criticality Detection System (CDS) is required in situations where, Aa criticality accident is determined to be impossible due to the physical form of the fissionable material, or the probability of occurrence is determined to be less than 10E-6 per year (DOE O 420.1, *Facility Safety*).@

As presented in Section 6.1.2, given the physical form of the waste, it is not credible for a criticality to occur. Therefore, there is no requirement to provide either a CDS or a CAS. This conclusion will be reevaluated as the design evolves.

6.2. ADMINISTRATIVE PRACTICES{tc \l2 "6.2. ADMINISTRATIVE PRACTICES}

The TWRS-P Facility maintains an appropriate criticality protection program to ensure nuclear criticality safety. This program is commensurate with the expectation that the waste being processed contains only low concentrations of fissile material and that a criticality is not a credible event. The program, therefore, incorporates only those program responsibilities, training, passive and active controls (if required), and self assessments of the program as needed to provide assurance of criticality safety.

6.2.1 NCS Organizational Responsibilities {tc \l3 "**6.2.1 NCS Organizational Responsibilities }**

The TWRS-P Facility Operations Manager is primarily responsible for ensuring criticality safety through the control of the operations within the TWRS-P Facility. The Operations Manager is assisted in this responsibility by the Environment, Safety, and Health (ES&H) Manager and the TWRS-P Project Safety Committee.

The TWRS-P Facility criticality protection program requires that management clearly establish responsibility for any elements of nuclear criticality safety needed. At this time, the only such element would be ensuring the fissile concentration of incoming waste and providing evaluations of changing conditions and of out-of-specification waste feed.

6.2.2 Configuration Management{tc \l3 "**6.2.2 Configuration Management}**

Section 3.1, AConfiguration Management,@ describes the TWRS-P Facility configuration management process. Because no criticality control parameters are required as part of the process to ensure criticality safety, it is not anticipated that NCS will present specific configuration management issues. This conclusion will be reviewed and modified, as appropriate, as part of the SAR process.

6.2.3 Maintenance{tc \l3 "**6.2.3 Maintenance}**

Section 3.2, AMaintenance,@ describes the maintenance considerations that apply to the TWRS-P Facility. Because no criticality control parameters are required to ensure criticality safety within the facility, there are no specific NCS maintenance requirements associated with the TWRS-P Facility.

6.2.4 Quality Assurance {tc \l3 "**6.2.4 Quality Assurance }**

Section 3.3, AQuality Assurance,@ describes the QA arrangements to be implemented for the TWRS-P Facility.

6.2.4.1 QA of NCS Controls. Because no criticality control parameters are required to ensure criticality safety within the facility, there are no specific NCS QA arrangements associated with the TWRS-P Facility except as related to ensuring incoming waste samples will be capable of identifying batches where the fissile material concentration exceeds allowable limits. However, if subsequent analysis reveals the need for NCS controls, these controls will be designated as Design Class I and Quality Level I as described in Section 3.3, AQuality Assurance.@

6.2.4.2 QA for NCS Evaluations. Any NCS evaluations performed are independently reviewed and verified by competent NCS analysts.

6.2.4.3 Verification of NCS Specifications for New of Modified Equipment Before its Use. Section 3.1, AConfiguration Management,@ outlines the arrangements in place for the control of the use of new or modified equipment. Criticality safety is an integral part of any approval procedure for new equipment; suitably qualifed and experimental personnel will provide advice in all cases.

6.2.5 Training{tc \l3 "6.2.5 Training}

To maintain an appropriate level of awareness of criticality safety, management provides time for employee training in criticality safety. General awareness training is provided for all employees, and specific technical training is provided where appropriate. Training is discussed further in Section 3.4, ATraining and Qualifications.@

6.2.6 Operational Inspections, Audits, Assessments, and Investigations{tc \l3 "6.2.6 Operational Inspections, Audits, Assessments, and Investigations}

As part of the audits and assessments program, NCS administrative procedures are reviewed for adequacy and areas of improvement. The audits and assessments program is further discussed in Section 3.6, AAudits and Assessments.@

6.2.7 Written Operating Procedures{tc \l3 "6.2.7 Written Operating Procedures}

TWRS-P Facility waste treatment operations and routine maintenance tasks are governed by written procedures. Except for ensuring that the fissile concentration of incoming waste is acceptable, no criticality procedures are envisioned at this time. If criticality becomes credible at the TWRS-P Facility, appropriate procedures will be developed.

6.2.8 Materials Control for NCS{tc \l3 "6.2.8 Materials Control for NCS}

At this time, no material controls related to NCS are required for the TWRS-P Facility. If NCS controls are identified, the controls will be maintained as discussed in Section 3.1, AConfiguration Management.@

6.2.9 Emergency Preparedness{tc \l3 "6.2.9 Emergency Preparedness}

Chapter 9.0, AEmergency Management,@ addresses placing the facility in a safe state following off-normal and accident conditions. Chapter 9.0 also addresses reentry, personnel accountability, care for injured personnel-alarms and sirens, and notification for facility emergencies. Additional information on notification also is provided in Section 3.7, AIncident Investigations.@

The consequences of a criticality event are not evaluated because the event has been shown to be incredible, and therefore adequately prevented. This conclusion is reflected in the BNFL Inc. emergency preparedness plans and procedures with respect to the potential for criticality. If, as a result of design evolution, an increased potential for criticality is identified, appropriate emergency plans and procedures to deal with the consequences of any potential criticality event will be specified in addition to suitable and sufficient criticality controls for prevention.

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7.0 CHEMICAL SAFETY{tc \l1 "7.0 CHEMICAL SAFETY}

The Tank Waste Remediation System-Privatization (TWRS-P) Facility chemical safety program (CSP) ensures that activities involving hazardous chemicals are conducted so that the safety and health of workers, the public, and the environment are protected. This program satisfies the requirements of 29 CFR 1910.119, AProcess Safety Management of Highly Hazardous Chemicals,@ and complies with 29 CFR 1910, AOccupational Safety and Health Standards;@ 29 CFR 1910.120, AHazardous Waste Operations and Emergency Response@; and 29 CFR 1910.1200, AHazard Communication.@ In addition, the program satisfies the requirements of the *Emergency Planning and Community Right-to Know Act of 1986*, Title III, Pub. L. 99-499 (PL 99-0499).

The CSP ensures chemical safety using a number of engineered features and administrative controls. The CSP requirements include the following measures:

1) Work is conducted in accordance with approved procedures
2) Informational resources (e.g., material safety data sheets) are available
3) Activities involving process chemicals undergo safety review
4) Engineered safety controls are applied
5) Effective protective measures or equipment are specified
6) Employees are appropriately trained and qualified
7) Hazards are identified and labeled
8) Management oversees activities.

Additional information concerning administrative controls is contained in Section 4.4, AProcess Safety Information.@

7.1 CHEMICAL SAFETY RESPONSIBILITY{tc \l2 "7.1 CHEMICAL SAFETY RESPONSIBILITY}

The Environment, Safety, and Health manager is responsible for developing, maintaining and operating the CSP. ES&H manager is also responsible for ensuring that procedures, training, and chemical safety protection are maintained in accordance with the program and that the program is in compliance with regulatory requirements.

In addition, facility workers that use hazardous chemicals are responsible for conducting activities in a safe manner as designated in the procedures and training programs. This includes knowing the hazards, characteristics, and safety requirements associated with the particular chemicals prior to beginning the work. Additionally, workers have the responsibility and authority to stop work when they believe the potential exists for a hazardous situation to result from a work activity.

Finally, work area supervisors are responsible for ensuring the safety of the work conducted under their purview. Supervisors ensure that personnel are selected to complete tasks safely based on their qualifications, training, and abilities to perform the task requirements. Supervisors also ensure the adequacy of work procedures and protective safety equipment.

7.2 CHEMICAL SAFETY APPROACH{tc \l2 "7.2 CHEMICAL SAFETY APPROACH}

The CSP relies on a number of controls to ensure the health and safety of workers and the public and the protection of the environment. The controls include a preference for design features over administrative controls. The process safety management system is used to identify, eliminate, or mitigate, to the extent possible, hazards and hazardous situations resulting from facility process chemicals. In support of process safety management, the CSP prompts an evaluation of whether the process can be conducted in a manner that does not involve hazardous chemicals, can be conducted with a substitute chemical that is not hazardous, or minimizes the volume of hazardous materials. Each task conducted within the facility is evaluated to identify potential hazards associated with chemicals. With the hazards characterized, controls are applied with the same priorities specified for the process safety management process. The goal of these activities is to minimize the potential exposure to workers, potential releases and impacts to the environment, and minimize waste volumes and waste management activities. The key features of the program aid in achieving program goals and are described below.

7.2.1 Chemical Inventory{tc \l3 "7.2.1 Chemical Inventory}

The TWRS-P Facility contains process chemicals that could be hazardous to workers and to the environment in hazardous situations. The list below contains the process chemicals derived from Table 4-2 of the Hazards Analysis Report (HAR) (BNFL 1997d).

1) Sodium hydroxide (NaOH)
2) Ferric Nitrate $Fe(NO_3)_3$
3) Strontium Nitrate $Sr(NO_3)_2$
4) Nitric Acid (HNO_3)
5) Alumina (Al_2O_3)
6) Boric acid (H_3BO_3)
7) Calcium silicates ($CaSiO_3$)
8) Copper oxide (CuO)
9) Ferric oxide (FeO_3)
10) Lithium carbonate ($LiCO_3$)
11) Magnesium silicate (Mg_2SiO_4)
12) Silica (SiO_4)
13) Zinc oxide (ZnO)
14) Zircon sand ($ZnSiO_4$)
15) Ammonia (NH_3)
16) Silver Zeolite
17) Sodium nitrite ($NaNO_2$)
18) Crystalline silico-titanate (CST)
19) Alumina catalyst
20) Superligand 644
21) Superligand 639.

Ammonia and nitric acid are listed in of 29 CFR 1910.119, Appendix A, ΑList of Highly Hazardous Chemicals, Toxics and Reactives.@ These chemicals are present in the facility in quantities or concentrations that are defined as highly-hazardous chemicals. The TWRS-P Facility specific process does not include a flammable liquid or gas (as defined in 29 CFR 1910.1200) onsite in one process, in a quantity of 4,535.9 kg (10,000 lb) or more.

The presence of 29 CFR 1910.119, Appendix A, chemical quantities and concentrations in the facility requires the structured assessment specified in 29 CFR 1910.119, ΑProcess Safety

Management of Highly Hazardous Chemical.@ Facility hazards associated with hazardous process chemicals were systematically evaluated (HAR, Chapter 4.0, AHazard Identification@).

In addition to the 29 CFR 1910.119 threshold, the quantities of nitric acid and ammonia exceed the threshold planning quantities of 40 CFR 355, AEmergency Planning and Notification,@ Appendix A, AList of Extremely Hazardous Substances and their Threshold Planning Quantities.@ The threshold quantities for these chemicals are 1,000 pounds for nitric acid and 500 pounds for ammonia. These quantities trigger the community emergency planning and notification requirements of 40 CFR 355. Planning and notification details are provided in Chapter 9.0, AEmergency Management.@

In addition to the process chemicals identified in Table 4-2 of the HAR, a limited number of common consumer products containing hazardous materials (e.g., batteries, paints, solvents, lubricants, and office products) are used in facility maintenance and operations activities. These items are used and disposed of in accordance with manufacturers directions (e.g., MSDS).

7.2.2 Procedures{tc \l3 "7.2.2 Procedures}

The CSP is implemented using procedures that are developed, reviewed, approved, and maintained as described in Section 3.9, AProcedures.@ The procedures contain the implementation requirements for both process safety management and for occupational safety.

Process safety management requirements are developed by determining safe operating parameters for the hazards identified in the HAR. Identified process hazards that need to be mitigated or eliminated are traceable to engineered features and operating procedure requirements. Those requirements that satisfy a safety basis requirement are identified as such in the procedure text.

Work procedures or technical work instructions also contain occupational safety requirements for protection of workers from exposure to hazardous chemicals within the facility. Procedures include requirements for chemical storage, use, labeling, and disposal. These procedures implement the requirements of 29 CFR 1910.120 and 29 CFR 1910.1200

7.2.3 Training{tc \l3 "7.2.3 Training}

Facility process and work tasks are conducted by individuals qualified within the facility training program. Employee training is a management tool that ensures safe and efficient conduct of work involving hazardous chemicals. Details of the program are provided in Section 3.4, ATraining and Qualification.@

7.2.4 Maintenance{tc \l3 "7.2.4 Maintenance}

The facility has a maintenance program for process equipment used to process, store, or handle hazardous materials. A primary purpose of the maintenance program is to minimize the risk of accidental releases of hazardous materials that could affect the workers, public, or the environment. Details of the maintenance program are provided in Section 3.2, AMaintenance.@

7.2.5 Configuration Management{tc \l3 "7.2.5 Configuration Management}

The configuration management process controls modifications to Design Class I and II structures, systems, and components (SSCs), procedures, materials, and process equipment. The process ensures that modifications afford equivalent or increased protection from hazardous material releases and exposures. The process is discussed in detail in Section 3.1, AConfiguration Management.@

7.2.6 Emergency Planning{tc \l3 "7.2.6 Emergency Planning}

The planning for facility contingencies involving hazardous materials is detailed in Chapter 9.0, AEmergency Management.@ The facility emergency plan ensures that under unlikely or extremely unlikely circumstances, appropriate emergency actions are implemented to mitigate or avoid hazardous material releases; releases are promptly characterized; onsite and offsite entities are notified; resources for coping with problems are available; and workers, the public and the environment are protected.

7.2.7 Incident Investigation{tc \l3 "7.2.7 Incident Investigation}

Incidents involving hazardous chemicals are investigated using the concept discussed in Section 3.7, @Incident Investigations.@ The incident investigation program is not specific to hazardous chemicals; it includes all incidents that affect or could affect the safe operation of the facility, or the health and safety of workers, the public, and the environment.

The primary goal of the incident investigation program is to determine the root cause of incidents so appropriate corrective action is applied to resolve a problem. Incidents, as used here, are those events that either have degraded or could degrade the effectiveness of facility Design Class I or II SSCS. Incidents include those seemingly minor events that, although harmless at the time, could be recognized as a trend toward more serious events.

7.2.8 Audits and Assessments{tc \l3 "7.2.8 Audits and Assessments}

Audits and assessments are management tools used to ensure that facility performance goals and safety commitments are tracked and accomplished and to identify and encourage performance improvement opportunities. Details of the program are provided in Section 3.6, AAudits and Assessments.@

7.2.9 Quality Assurance{tc \l3 "7.2.9 Quality Assurance}

The facility QA program is another management tool used to ensure the quality of components and program elements involving the safety of facility hazardous materials. Section 3.3, AQuality Assurance,@ provides details of the program.

7.2.10 Human Factors

The facility design incorporates human factor elements to optimize the human-to-hazardous-material control interfaces. This allows optimal control, and therefore safety over processes, process monitoring, and chemical handling activities. Details of this control are provided in Section 3.5, AHuman Factors.@

7.3 CHEMICAL SAFETY CONTROLS{tc \l2 "7.3 CHEMICAL SAFETY CONTROLS}

A variety of engineered and administrative controls are used to maintain the safe condition of the process chemicals. The type and extent of the controls applied are driven by the hazard analysis. Chemical-related hazards are identified and evaluated, along with other facility hazards, in Section 4.7, AResults of the ISA.@

The first design priority, with respect to hazard control, is to eliminate the hazard entirely, if possible. This is accomplished in a variety of ways, including substitution of chemicals, avoiding non-essential hazardous processing steps, and eliminating the possibility of contact with incompatible chemicals. Eliminating the hazard entirely is the most reliable concept for controlling facility hazards.

If identified hazards cannot be eliminated, engineered features are applied to mitigate both the probability of occurrence and the magnitude of the event. Engineered features include both passive and active devices such as ventilation systems; leak detection and confinement devices; flow and energy control devices; emission controls; and inerting and suppression systems.

To further minimize hazards from chemicals, administrative controls are also applied. Examples include procedural requirements, personnel training, technical reviews, and access controls.

Specific chemical safety controls are identified, evaluated, and applied to individual hazards or systems as the facility design matures.

7.4 CHEMICAL SAFETY FOR WORKERS{tc \l2 "7.4 CHEMICAL SAFETY FOR WORKERS}

In addition to the facility safety design aspects, the CSP includes a variety of features to protect the workers from exposure and other hazards associated with hazardous chemical work. The program complies with 29 CFR 1910. However, these standards are met and additional program requirements affording a higher level of safety may be adopted by the CSP, where practicable. *(Process controls will be described further in Section 7.3 during Part B, as the facility design matures. Administrative controls become more important in an occupational setting when maintenance, waste management, or nonroutine activities are conducted.)*

With respect to hazardous chemicals, TWRS-P Project administrative controls include, but are not be limited to the following:

1) Conduct of work by formal procedure
2) Safety preview and post review of work involving hazardous materials
3) Specification of appropriate protective clothing and equipment
4) Use of access controls
5) Application of lock and tag requirements
6) Personnel and workplace monitoring
7) Exposure tracking and control
8) Records management system
9) Application of QA and quality control requirements
10) Task planning and prejob briefings
11) Worker training and qualification
12) Hazardous material identification, evaluation, and control

13) Hazardous material labeling and posting
14) Access to and adherence to reference safety material (e.g., Material Safety Data Sheets)
15) Authorization for worker stop-work authority.

7.5 CONSEQUENCE ESTIMATES{tc \l2 "7.5 CONSEQUENCE ESTIMATES}

The hazard consequences of TWRS-P Facility chemical release scenarios are projected as described in Section 4.7, AResults of the ISA.@

8.0 FIRE SAFETY{tc \l1 "8.0 FIRE SAFETY}

BNFL Inc. implements its Fire Safety Management Program (FSMP) and fire protection system design for the Tank Waste Remediation System-Privatization (TWRS-P) Facility through a defense-in-depth approach. The FSMP is implemented by achieving the following objectives:

1) Preventing fires from starting

2) Quickly detecting any fires that do start and alerting fire fighting personnel

3) Preventing the spread of fires and products of combustion

4) Rapidly extinguishing fires that do start through fire suppression systems or manual intervention.

These objectives are achieved through a number of design and engineered features in combination with management controls. Detailed descriptions of the design and engineering features are provided in Section 4.3.8,@ Fire Protection System.@ Section 4.3.8 and Section 4.6.5, AFire Hazards Analysis,@ describe a fire protection system design that allows occupants to escape to a place of safety, protects equipment, minimizes radiological and chemical exposure to personnel, minimizes fire spread, limits property loss, and prevents releases to the environment.

8.1 FIRE SAFETY MANAGEMENT{tc \l2 "8.1 FIRE SAFETY MANAGEMENT}

During design and construction of the TWRS-P Facility, the General Manager is responsible for establishing the fire safety policy. The architect engineer is responsible for a fire prevention system design that meets regulatory requirements and fire protection engineering principles. Individuals who develop the design of the fire protection system and specify fire protection equipment meet requirements to qualify as a member in the society of Fire Protection Engineers. The Construction Manager is responsible for developing and implementing an effective fire safety program and the Environment, Safety, and Health (ES&H) organization functions as fire safety experts and implements a fire safety inspection function. The ES&H organization provides an individual who meets the requirements to qualify as a member in the Society of Fire Protection Engineers.

BNFL Inc. uses an integrated fire safety management process to identify and eliminate or control fire hazards. The fire safety design of the TWRS-P Facility reflects the measures that have been deemed appropriate to mitigate the risk from fire to personnel, property, and the environment by the application of regulatory requirements and fire engineering principles. Fire safety policies and procedures are used in each phase of the facility's life to assure fire risks are controlled. For the startup and operational phases, these policies and procedures are located in the FSMP manual. This manual addresses the following topics:

1) Fire safety training for TWRS-P Facility staff, emergency response personnel, and visitors

2) The pre-fire plan

3) Procedures for performing work that may affect the fire safety arrangements of the facility, including the introduction of transient materials that could affect the fire severity or temporarily increase the fire loading of the area, and management controls of hot working operations (welding and cutting)

4) Routine testing, maintenance, and servicing of fire protection systems and equipment

5) Record keeping of maintenance and servicing of fire protection systems and equipment

6) Procedures for the assessment of the fire risk of any new or replacement materials proposed for use at the facility

7) Management plans for fire safety inspections to ensure that the integrity of the fire safety design has been maintained and that the control of fire risk remains effective

8) Fire prevention policy addressing subjects such as control of flammable and combustible materials, control of ignition sources, fire extinguisher use, and fire prevention training.

The pre-fire plan provides written directions for the following actions:

1) Response to fire alarms and fire system supervisory signals

2) Specific fire-mitigation activities to be accomplished for each fire confinement area

3) Directions for personnel evacuation

4) Notification of designated personnel and organizations

5) Coordination with security forces, radiation protection personnel, and other designated personnel for the admission of offsite emergency vehicles and personnel

6) Conduct of periodic coordinated drills and exercises to verify the adequacy of the pre-fire plan.

The plan includes drawings that identify the location of equipment used for automatic and manual suppression of fires and the location of concentrations of combustibles and other hazards.

During startup testing and operations, the General Manager is responsible for defining fire safety policy. The Facility Manager is responsible for developing and implementing an effective FSMP. The Operations Manager is responsible for overall management, organization, and coordination of manual fire fighting activities. The ES&H organization functions as fire safety experts and implements a fire safety inspection function. The ES&H organization provides an individual who meets the requirements to qualify as a member in the society of Fire Protection Engineers. Qualified ES&H staff members participate in the inspection and startup testing of the fire protection system. The qualified staff reporting to the ES&H manager, are assigned the following duties:

1) Perform periodic fire safety inspections

2) Assist operations and technical support in the training of the fire brigades, other staff members, and visitors

3) Assist operations and technical support to prepare fire protection-related procedures and training materials

4) Review, as requested, maintenance work plans for the purpose of identifying possible fire hazards and recommending fire prevention measures

5) Pre-plan and critique the performance of fire brigade drills.

The Shift Manager is responsible for responding to fire-related incidents in accordance with emergency plans and procedures. Included in this responsibility is the direction of immediate fire fighting activities and coordination with the Hanford Fire Department.

8.2 FIRE PREVENTION PROGRAM{tc \l2 "8.2 FIRE PREVENTION PROGRAM}

BNFL Inc. implements a fire prevention program throughout each phase of the project. Common elements of these programs are personnel training on fire prevention, control of flammable and combustible materials, control of ignition sources, and identification of steps to be taken during periods when the fire protection system is impaired. The fire prevention program for each phase also incorporates inspections of fire protection activities. Procedures address the management controls implemented for each phase of the project. The FSMP manual documents the management policies and controls for the startup testing and operational phases.

The FSMP manual requires an evaluation of maintenance activities to identify those that represent an increased likelihood of fire. These activities (primarily cutting, welding, or other uses of an open flame) require special precautions, including hot work permits and the stationing of a qualified individual to monitor and respond to any ignition event. Compensatory controls are established for activities that may impair fire prevention or mitigation features.

The FSMP manual requirements for response to impairments of the fire protection system include the following:

1) Identification and tracking of impaired equipment
2) Identification of personnel to be notified
3) Determination of needed fire protection and fire prevention compensatory measures.

For planned impairments, the necessary parts and personnel are available prior to removing the system from service. For unplanned impairments, the fire protection system restoration is expedited.

The FSMP manual prohibits the storage of significant quantities of flammables and combustibles in or adjacent to locations of the facility where the function of Design Class I structures, systems and components (SSCs) could be compromised. Combustible loading limits in the FSMP are based on the results of the fire hazards analysis. Emphasis is placed on the control of transient combustibles (mainly packaging materials and materials used to support maintenance activities), control of construction sites, proper storage of hazardous material (either materials used in the facility processes or materials required to support maintenance activities), and disposal of waste-absorbent material.

The FSMP manual provides the management controls required to implement preventative maintenance, performance testing, and inspection programs that ensure reliable performance of fire protection features and systems. Maintenance, testing, and inspection features are designed into the fire protection system. These controls are based on system and component manufacturer=s recommendation and on applicable requirements of National Fire Protection Association (NFPA) Standard 801, *Standards for Fire Protection for Facilities Handling Radioactive Materials* (1997 draft), and the other appropriate standards endorsed by NFPA 801.

The structured process for the review of facility and process modifications described in Section 3.1.4, AChange Control,@ and Section 3.3.4.5, ADesign,@ includes reviews by individuals qualified and knowledgeable of regulatory requirements, fire protection engineering principles, and the design basis of the TWRS-P Facility fire protection features.

The Quality Assurance and ES&H organizations periodically perform fire safety inspections to ascertain that fire defenses are in place, emergency equipment is readily available and in operating order, combustibles are held to minimal quantities, and housekeeping is maintained at a high level. In addition, the TWRS-P Project Safety Committee evaluates the overall performance in the area of fire protection by reviewing inspection reports; by reviewing and approving modifications; and by reviewing incident reports.

8.3 FIRE PROTECTION FEATURES AND SYSTEMS{tc \l2 "8.3 FIRE PROTECTION FEATURES AND SYSTEMS}

The design of the TWRS-P Facility fire protection system is based on the requirements of NFPA 801 and the other appropriate standards endorsed by NFPA 801. This standard allows selection of alternative methods, systems or devices. Any alternative methods used in the design of the TWRS-P Facility provide an equivalent level of fire protection and are justified in the fire hazards analysis described in Section 4.6.5, AFire Hazards Analysis@.

The process building is designed and constructed of noncombustible or limited combustible materials and complies with the standards of Type 1 construction as defined in NFPA 220, *Standard Types of Building Construction*. The building incorporates safety features in accordance with NFPA 101, *Life Safety Code*. The process building is subdivided into separate fire areas for the purpose of limiting the spread of fire. These fire confinement areas are separated by fire-resistance-rated barriers commensurate with the expected fire severity. Openings in these barriers are protected with automatic or fixed fire-resistance-rated closure devices such as doors, windows, dampers, or seals. Penetration seals meet the requirements of UL 1479, *Fire Tests of Through-Penetration Fire Stops*. Fire doors used in fire barriers, are designed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*. Sections 4.2.1, ABuilding Descriptions,@ and Section 4.6.5, AFire Hazards Analysis,@ describe the building layout including separate fire confinement areas, egress routes, and fire loading impacts resulting from materials of construction.

Electrical wiring, components, and systems comply with the applicable provisions of NFPA 70, *National Electrical Code*. Design details for the electrical systems are described in Section 4.3.10, AElectrical Power.@ Lightning protection is installed for all buildings and tall structures in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems*. Critical operations areas and egress routes are provided with emergency lighting in accordance with NFPA 101.

The ventilation system is designed to prevent the spread of heat and combustion products throughout the building in the case of fire. Fire dampers and fire cladding of ductwork prevent smoke and heat transport by the ventilation system. The balance between the need to maintain radiological confinement and also remove smoke in the case of fire requires close coordination between fire engineers and ventilation engineers. The fire hazards analysis described in Section 4.6.5 confirms that the building fire compartmentalization and radiological containment criteria are satisfactorily achieved. The ventilation system complies with the requirements of NFPA 90A, *Standard for Installation of Air Conditioning and Ventilating Systems*, and NFPA 92A, *Smoke Control Systems,* and is more fully described in Section 4.3.7.1,AProcess Building HVAC.@ The design of nonprocess building ventilation systems are based on the location and function of the buildings and are described in Section 4.3.7.2, ANonprocess Building HVAC Systems.@

The fire hazard analysis (*to be performed during Part B*) demonstrates that the TWRS-P Facility, including all buildings, can be placed in a safe state for all credible fires and explosion conditions. The only significant amounts of combustible liquid storage on site is the diesel fuel tanks for the diesel fire pump, boilers, and the emergency diesel generator. The TWRS-P Hazards Analysis Report (HAR) (BNFL 1997d) identifies process steps that generate hydrogen. These process steps use ventilation measures to prevent the creation of flammable mixtures. The fire hazards analysis demonstrates the adequacy of fire protection measures used in the case of spilled diesel fuels or creation of flammable mixtures with hydrogen.

The fire protection system consists of several subsystems for fire detection and alarm, for fire water supply, and for fixed automatic and manual fire suppression. The fire detection and alarm system includes the instrumentation and controls required for detecting and identifying the location of the fire, providing alarms, monitoring the fire protection system status, and actuating automatic fire suppression systems. The fire water system includes fire water storage tanks, pumps, piping, valves, and other components needed to deliver water to fire hydrants, standpipes, and fixed suppression systems. Fire water makeup is provided by a fire water line from the existing 200 East Area fire suppression distribution system. Fire protection water is distributed by an underground yard main loop with sectionalizing valves to ensure fire water delivery in the case of failure of a sector of the loop.

The suppression systems include fire hydrants, standpipes and hose stations, deluge water spray to the ventilation charcoal canisters and high-efficiency particulate air (HEPA) filters, and building sprinklers. Fixed automatic and manual fire suppression systems are provided in selected building fire areas as required by the Fire Hazards Analysis. The selection of the type of systems for each plant area is based on the guidance in NFPA 801. Fire suppression systems including portable fire extinguishers are designed, installed, and deployed in accordance with standards endorsed by NFPA 801.

8.4 MANUAL FIRE-FIGHTING CAPABILITIES{tc \l2 "8.4 MANUAL FIRE-FIGHTING CAPABILITIES}

Manual fire-fighting activities during construction of the facility are the responsibility of construction management and will consist of personnel trained to use portable fire extinguishers backed up by professional fire fighting resources from the Hanford Fire Department (HFD).
Response to fires at the TWRS-P Facility during the operations phase is a coordinated combination of onsite fire brigade resources and resources from the HFD. The fire brigade and the HFD are equipped with required fire fighting equipment and supplies. *(The exact size and composition of the onsite fire brigade and the specific equipment needed by the fire brigade and the HFD will be determined in Part B following completion of the fire hazards analysis and negotiations with the U.S. Department of Energy [DOE] contractor responsible for the HFD.*) The fire brigade is organized and functions in accordance with NFPA 600, *Standard on Industrial Fire Brigades*.

All areas of the facility are automatically monitored for fire/smoke. The fire alarm features include transmission of signals to the HFD via a radio fire alarm reporter. The standard response to an alarm condition in the 200 East Area is by the HFD from the 200 Area Fire Station which is fully staffed, trained, and equipped. The HFD response time to the TWRS-P Facility is approximately 5 minutes. *(This time is to be verified at the time of negotiations with the HFD.*) When staffed, a crew from the 100 Area Fire Station is dispatched simultaneously with an estimated response time of 10 minutes. (*This time is to be verified at the time of negotiations with the HFD.*) Vehicle access to the facility is provided by a paved access road (*to be built in Part B).*

If a fire meets the requirements for initiation of the Emergency Response Program as described in Chapter 9.0, AEmergency Management,@ the Shift Manager is responsible for ensuring that the emergency notification process is initiated. Upon actuation of the Emergency Response Organization, the Shift Manager will take direction from the Emergency Director.

8.5 FIRE SAFETY TRAINING{tc \l2 "8.5 FIRE SAFETY TRAINING}

TWRS-P Facility staff members are required to complete basic fire safety training applicable to the current phase of the project. This training ensures that onsite personnel understand fire hazards present on the site, elements of the fire prevention program applicable to their assigned responsibilities, and emergency response measures including means of egress and methods of reporting fires. Staff members receive refresher training periodically. Visitors and temporary employees are provided with instructions that identify evacuation routes and procedures for reporting fires. Periodic facility evacuation drills are held.

ES&H staff members receive fire safety training appropriate to their assigned duties. This training includes design and maintenance of fire protection equipment, fire prevention techniques, and fire fighting principles and techniques. Maintenance personnel involved in fire protection system testing, maintenance, and servicing receive training appropriate to their assigned duties.

Personnel assigned to the TWRS-P Facility fire brigade are trained by a combination of training methods including classroom instruction, hands-on fire fighting with equipment available at the facility, and drills and exercises. Training includes the following instructional areas:

1) Identification of fire hazards and types of fire that can occur at the facility, and identification of the location of fire, radiological, and chemical hazards, including areas or conditions where breathing apparatus is required

2) Familiarization with facility layout including access and egress routes to each area of the facility, and location of fixed and portable fire fighting equipment

3) The proper use of available equipment and the correct method of fighting each type of credible fire

4) The proper use of breathing apparatus, communications equipment, lighting, and ventilation systems

5) Indoctrination on the TWRS-P Facility fire fighting plan, with coverage of each individual's responsibilities.

Fire brigade leaders receive additional training in directing and coordinating fire fighting activities. Refresher instruction is provided periodically to all fire brigade members. TWRS-P Facility fire brigade training and practices are in accordance with NFPA 600.

The HFD is responsible for training its employees. The HFD response team members are trained to respond to events that occur in radiological and hazardous material environments. Annual training on the TWRS-P Facility pre-fire plan, including a tour of the facility, is provided for HFD responders.

9.0 EMERGENCY MANAGEMENT{tc \l1 "9.0 EMERGENCY MANAGEMENT}

The Tank Waste Remediation System - Privatization (TWRS-P) Project emergency management program is implemented and maintained to ensure that the personnel are ready to respond promptly, efficiently, and effectively to any emergency involving TWRS-P Project facilities, activities, or operations. The applicable requirements of Federal, state, and local agencies are integrated into a single comprehensive program. The magnitude and scope of the program is commensurate with the hazards present at the facility.

The TWRS-P Project emergency management program functions within the preexisting Hanford emergency management community. Community planning partners include the U.S. Department of Energy (DOE); DOE contractors; the Washington Public Power Supply System; U.S. Ecology; the State of Washington; and Benton, Franklin, and Grant counties. The TWRS-P Project emergency management program is consistent with the Hanford Emergency Response Plan (DOE/RL 94-02, or its replacement), to ensure an integrated response and to eliminate duplication of effort within the planning community. Wherever possible, agreements enable the TWRS-P Project to use existing Hanford response capabilities (e.g., fire, medical, hazardous materials spill response, consequence assessment, law enforcement, and communications).

This chapter discusses the elements of the TWRS-P Project emergency management program. *(Additional detail will be contained in the Part B Preliminary Safety Analysis Report [PSAR] and a final draft of the TWRS-P Project Emergency Response Plan will be submitted at the time of the Final Safety Analysis Report [FSAR]. During program development, all applicable Federal, state, and local emergency preparedness requirements will be identified and addressed.)*. The program description provided here is intended to be compliant with the requirements of 40 CFR 68, AChemical Accident Prevention Provisions,@ 40 CFR 355, AEmergency Planning and Notification,@ 29 CFR 1910.38, AEmployee Emergency Plans and Fire Prevention Plans, DOE/RL 94-02, AHanford Emergency Response Plan@ WAC 173-303-350 *Dangerous Waste Regulations, Emergencies*. This chapter documents how the project staff intends to attain an acceptable state of emergency preparedness prior to the time the facility becomes operational.

9.1 EMERGENCY FACILITIES, SERVICES, AND EQUIPMENT{tc \l2 "9.1 EMERGENCY FACILITIES, SERVICES, AND EQUIPMENT}

This section describes facilities, services and equipment established and maintained by the TWRS-P Project or that are available on the Hanford Site to support response to emergencies. During the design and construction phase of the project, the emergency planning staff and designers establish facility features such as systems, structures, and components (SSCs) that are needed to allow for extended emergency operations. During radioactive startup, operations, and deactivation phases, the facilities and equipment are maintained in the required state of readiness. During emergency conditions, the workers and emergency response personnel take actions in accordance with plans and procedures.

9.1.1 Emergency Facilities and Services{tc \l3 "9.1.1 Emergency Facilities and Services}

This section discusses the emergency facilities and services established and maintained by the TWRS-P Facility or that are already available on the Hanford Site.

9.1.1.1 Incident Command Post{tc \l4 "9.1.1.1 Incident Command Post}. An Incident Command Post is established in a safe location near the event scene where emergency responders from different organizations can assemble to coordinate actions. At the Incident Command Post the Incident Commander directs a unified command of on-scene emergency response efforts.

9.1.1.2 Emergency Operations Center{tc \l4 "9.1.1.2 Emergency Operations Center}. The TWRS-P Facility Emergency Operations Center (EOC) serves as the primary location from which the TWRS-P Project emergency response organization provides management, logistics, evaluation, communication, coordination, and technical support to the on-scene response effort. The EOC also functions as the point of contact with the Hanford Site emergency response organization, state and local response organizations, regulatory agencies, workers, the public, and the media during emergency response. *(The EOC may be designed as a dual use space within the TWRS-P Facility.)*

Procedures require rapid activation and staffing of the EOC in emergencies. The EOC working space, equipment, reference materials, and supplies enable the assigned staff to carry out their designated response functions. The area, supporting equipment, reference material and supplies are maintained in a continuous state of readiness. The EOC is able to support staff operations for extended periods of time during emergency response. Emergency implementing procedures address personnel relocation and activation of the alternate EOC *(During Part B, if it is determined that the EOC could become uninhabitable during an emergency, an alternate location will be identified and sufficiently equipped to support response.)*

9.1.1.3 Emergency Public Information{tc \l4 "9.1.1.3 Emergency Public Information}. An area or facility from which information can be disseminated to the public and news media is designated. *(Consideration will be given to forming an agreement to use the Hanford Joint Information Center (JIC), from which public information activities at the Hanford Site are currently coordinated with offsite agencies. The Hanford Site JIC is located at the Federal Building, 825 Jadwin Avenue, Richland, Washington.)*

9.1.1.4 Emergency First Aid and Medical Treatment for Onsite Personnel{tc \l4 "9.1.1.4 Emergency First Aid and Medical Treatment for Onsite Personnel}. The TWRS-P Facility is equipped with standard industrial first aid equipment and supplies in accordance with applicable Federal, state, and local regulations. Mutual aid agreements with Hanford emergency response organizations ensure rapid access to emergency medical services.

Professional medical services are for the Hanford Site provided by the Hanford Environmental Health Foundation. Doctors and nurses are available on short notice for emergency assistance. These personnel are trained to work with trauma from industrial injuries, contaminated injured people, and those who may have been exposed to hazardous materials. A nurse is on duty in the Hanford 200 Areas. Site ambulance service is provided by the Hanford Fire Department, which has qualified emergency medical technicians as attendants and drivers. This service is available from each area fire station on a 24-hour basis. Contractual agreements will be established with private ambulance companies to provide additional service as necessary. Local hospital services are available at Kadlec Medical Center in Richland, Washington; Kennewick General Hospital in Kennewick, Washington; and Our Lady of Lourdes Health Center in Pasco, Washington.

Decontamination facilities, equipment, and supplies are maintained at the TWRS-P Facility to assist the trained and equipped technicians that are available for decontamination activities. For severely injured and contaminated patients, agreements will be made to use the Hanford Emergency Decontamination Center located behind and immediately north of Kadlec Medical Center in Richland. The Emergency Decontamination Center is a specially designed decontamination and radiosurgery facility that provides both decontamination and isolation services.

9.1.1.5 Fire Response{tc \l4 "9.1.1.5 Fire Response}. The TWRS-P Facility is equipped with the required fire safety equipment and supplies. See Chapter 8.0, AFire Safety@, for specifics of fire protection. *(BNFL Inc. plans to develop a mutual aid agreement to allow the Hanford Fire Department to provide fire protection services for the TWRS-P Project. Mutual aid agreements with local fire departments will be established to provide additional backup capabilities.)*

9.1.1.6 Law Enforcement{tc \l4 "9.1.1.6 Law Enforcement}. The TWRS-P Facility is within the Hanford security boundary. Access to this area is controlled by the Hanford Patrol which provides site security services including protection of government information and property, activation of notification systems and sirens, coordination of the movement of emergency personnel through security gates, evacuation assistance, and barricade establishment where needed. The Hanford Patrol operates the Patrol Operations Center, a 24-hour operational facility, and is responsible for performing Hanford Site emergency notifications. The Hanford Patrol is designated in the Hanford Emergency Response Plan as the incident command agency for Hanford security emergencies. Enforcement of local laws on the Hanford Site has been contracted to the Benton County Sheriff=s Department. Additional law enforcement and security response capabilities are available, as necessary, through agreements with local and Federal agencies.

9.1.2 Emergency Equipment{tc \l3 "9.1.2 Emergency Equipment}

The TWRS-P Project Emergency Response Plan *(to be developed during Part B)* identifies dedicated emergency equipment and supplies, their location, and the requirements for calibration, maintenance, and inventory. *(BNFL Inc. plans to negotiate a mutual aid agreement to allow the TWRS-P Project to use the inventory of emergency equipment and supplies maintained on the Hanford Site as a backup.)* Prior to facility operation, adequate equipment and supplies are available and operable for emergency response personnel to carry out their assigned duties and responsibilities. Emergency and backup equipment (including monitoring devices) is located in readily accessible areas away from the scene of potential emergencies. Equipment is available (as appropriate) to provide the following functions for response to potential emergencies:

1) Emergency dosimetry

2) Personnel protection

3) Monitoring of personnel, facilities, and the environment for radioactive and hazardous material contamination

4) Emergency medical treatment onsite

5) Meteorological monitoring

6) Handling of personnel contaminated with radioactive or chemical materials

7) Emergency power, water, and sanitation

8) Emergency transportation for personnel evacuation

9) Equipment and supplies to respond to spills of hazardous chemicals

10) Emergency communications, including portable and communications equipment, as required.

To ensure equipment reliability, emergency equipment is, to the extent practical, the same equipment used for routine operations. The DOE and the Hanford Site contractors maintain a variety of equipment and supplies that are available through mutual aid agreements.

9.1.2.1 Communications Equipment{tc \l4 "9.1.2.1 Communications Equipment}. The following primary and backup means of communication are available and capable of operating with Hanford Site response elements, and with other Federal, state, and local response organizations, as applicable:

1) Commercial telephone and fax

2) Cellular telephone

3) Radios with capability to transmit on the Hanford Site safety network, Hanford Patrol, or Hanford Fire frequencies

4) Facility public address system.

The TWRS-P Facility is equipped with alarms or sirens as determined necessary by the results of the Safety Analyses or applicable regulatory requirements. The facility management ensures that preventative maintenance is performed on facility emergency sirens and alarms by the responsible maintenance organizations in accordance with established preventative maintenance procedures. Communications equipment, sirens and alarms are periodically tested.

9.1.2.2 Assessment Equipment{tc \l4 "9.1.2.2 Assessment Equipment}. Emergency equipment, as appropriate, allows a rapid and reliable determination of the seriousness of an accident. The types of equipment, for both emergency and continuing assessment, include area and process radiation detectors and alarms, portable radiation and toxic chemical detectors, meteorological instrumentation, computerized assessment models, and effluent and environmental monitoring equipment. The TWRS-P Project Emergency Response Plan identifies specific assessment equipment, locations, and the requirements for maintenance, calibration, and inventory.

(The DOE maintains specialized assessment capabilities including the Atmospheric Release Advisory Capability and the Aerial Measuring System that BNFL Inc. plans to request be made available to support the site response in the event of a major emergency involving hazardous materials.)

9.1.2.3 Personnel Protective Equipment{tc \l4 "9.1.2.3 Personnel Protective Equipment}. Supplies of personnel protective equipment adequate for supporting the response to potential emergencies at the TWRS-P Project are maintained. The type and quantities of equipment necessary are determined based on the hazardous materials present at the facility, number of response personnel, estimated duration of response activities, and time necessary to supplement or replenish supplies.

9.1.2.4 Decontamination Equipment and Supplies{tc \l4 "9.1.2.4 Decontamination Equipment and Supplies}. Equipment and supplies for performing hazardous material decontamination and handling the resulting waste are maintained. The types and quantities of equipment and supplies necessary are determined based on the hazardous materials present and the number of staff at risk.

9.1.2.5 Inventory of Emergency Equipment and Supplies{tc \l4 "9.1.2.5 Inventory of Emergency Equipment and Supplies}. In accordance with established inventory control procedures, TWRS-P Project emergency equipment and supplies are inventoried periodically, to ensure availability in the event of an emergency.

9.2 TYPES OF ACCIDENTS{tc \l2 "9.2 TYPES OF ACCIDENTS}

The scope of the emergency management program required for the TWRS-P Project is determined by the a Hazards Survey and Assessment for the facility. The Hazards Survey describes the potential impacts of emergency events or conditions and summarizes the federal, state, and local planning and preparedness requirements that apply. The Hazards Survey identifies the required scope of the TWRS-P Project emergency management program and documents all applicable requirements.

If the Hazards Survey identifies hazardous materials at the facility or site in excess of predetermined thresholds, a facility- or site specific-quantitative hazards assessment is performed. This assessment includes the identification and characterization of hazardous materials specific to the facility, analyses of potential accidents or events, and evaluation of potential consequences. The hazards assessment also includes a determination of the size of the geographic area surrounding the facility, known as the Emergency Planning Zone (EPZ), within which special planning and preparedness activities are performed to reduce the potential health and safety impacts from an event involving hazardous materials. The hazards assessment provides the technical basis for the TWRS-P Project emergency management program and includes information needed to determine the scope and extent of the specific elements composing the emergency management program. The extent of planning and preparedness directly corresponds to the type and magnitude of hazards present and the potential consequences of events.

The TWRS-P Facility hazards assessment includes determination of the following:

1) The range of possible initiating events
2) Accident mechanisms
3) Equipment or system failures
4) Event indications
5) Contributing events
6) Source terms

7) Material release characteristics
8) Topography
9) Environmental transport and diffusion
10) Exposure considerations.

The hazards assessment characterizes the potential consequence to responders, workers, and the public. A spectrum of potential accidents, ranging from minor to beyond-the-design basis, are realistically analyzed. While not every conceivable situation is analyzed, the hazards assessment covers the full range of possible impacts and provides the basis for identifying the response to virtually any emergency involving hazardous materials.

The TWRS-P Facility hazards assessment is performed in accordance with the requirements of DOE/RL 94-02, Section 4.1, AHazards Assessment@, and 40 CFR 68 Subpart B, AHazards Assessment@, as applicable. The methodology, assumptions, models, and evaluation techniques used in the hazards assessment are documented. The hazards assessment document is reviewed and updated as necessary, whenever the facility configuration, source terms, or operations are modified. The hazards assessment document is maintained in accordance with TWRS-P Project document control requirements.

9.3 CATEGORIZATION AND CLASSIFICATION OF EMERGENCIES{tc \l2 "9.3 CATEGORIZATION AND CLASSIFICATION OF EMERGENCIES}

In order to comply with the requirements of DOE/RL 94-02 and to be compatible with procedures of the Hanford Site emergency planning community, emergencies at the TWRS-P Project are categorized, then classified in the same manner as DOE AOperational Emergencies@. Operational Emergencies are defined as significant accidents, incidents, events, or natural phenomena that seriously degrade the safety or security of the facility. Events that exceed preestablished severity thresholds are categorized as Operational Emergencies, and events involving significant quantities of hazardous materials are further classified according to the potential hazardous material consequences. Events that are outside the range of normal operations but do not exceed the thresholds for categorization as emergencies are reported and documented in accordance with the incident reporting system described in Section 3.7, AIncident Investigation.@

Effective emergency response depends upon early recognition of emergency events and conditions, coupled with rapid implementation of emergency actions. Response to Operational Emergencies requires onsite response and notification of offsite authorities and may require the commitment of significant resources. The process of categorizing events as Operational Emergencies and of classifying hazardous material events is intended to ensure rapid recognition of, and response to, emergency conditions. The emergency categorization and classification system represents a set of preapproved decisions, agreed to by TWRS-P Project senior management and DOE, state, and local officials, that allows the onsite supervisory personnel to make rapid decisions affecting personnel, facilities, and resources in response to an emergency.

Events that seriously degrade safety or security, but do not involve the release of hazardous materials, are categorized as Operational Emergencies not requiring classification. Categorization is intended to ensure the rapid dissemination of event facts outward and upward, initiate strategic decision-making, and meet the time-sensitive information needs of facility management and offsite regulatory and response agencies. In addition to ensuring rapid communications, the classification of hazardous materials events initiates preplanned local response and actions to protect personnel at the TWRS-P facility, on the Hanford Site and the general public beyond the Hanford Site boundary.

The purpose of an event classification system is to:

1) Assure a common understanding, at the onset, of the severity of an emergency

2) Initiate a set of preplanned response actions appropriate to all events of a given class or severity (e.g., notification, mobilization of resources, and protective actions)

3) Activate necessary analytical and decision-making capabilities to make determinations of the need for other actions

4) Ensure mitigating action is taken to prevent conditions from becoming more severe

5) Provide sufficient lead time to activate response facilities and prepare for protective actions

6) Initiate the prompt and accurate flow of information.

Accurate event classification is key to achieving a graded response that mobilizes personnel and resources in proportion to the severity of events or conditions. An important purpose of event classification is to minimize the severity of an event by quickly bringing technical resources to bear on the problem.

Operational Emergencies involving the release of hazardous materials are differentiated according to their severity for the purpose of rapidly implementing response activities and notifications that are commensurate with the potential consequences of the event. There are three classification levels: Alert, Site Area Emergency, and General Emergency. The severity of each of the three Operational Emergency classes and the general area of possible impact are summarized in Table 9-1.

Table 9-1. Description of Emergency Classes

Emergency Class	Severity Level
Alert	Substantial actual or potential degradation of level of safety. Hazardous material releases not expected to exceed levels requiring protective actions at facility boundary.
Site Area Emergency	Actual or potential major failures of functions needed for protection of workers and public. Hazardous material releases expected to exceed levels requiring protective actions at or beyond facility boundary, but not offsite.
General Emergency	Actual or imminent catastrophic reduction of safety systems with actual or potential loss of hazardous material. Hazardous material releases expected to exceed levels requiring

Table 9-1. Description of Emergency Classes

Emergency Class	Severity Level
	protective action offsite.

The threshold of each emergency class is defined in terms of the actual or potential hazardous material consequences at receptor locations (e.g., contractor controlled area and the off-site receptor location [Figure 4-2]). The results of the TWRS-P Facility Hazards Assessment (see Section 9.2, ATypes of Accidents@) is used to identify specific event indicators (i.e., alarms, monitor readings, sample results, and observed conditions) that correspond to actual or potential emergency event consequences which equal or exceed a value termed the protective action criterion at the predetermined receptor locations. The protective action criterion is a threshold of exposure to hazardous materials beyond which actions must be taken to protect human health and safety. These indicators are the facility Emergency Action Levels (EALs). The EALs are the foundation for the development of an emergency preparedness implementing procedure for the categorization and classification of emergency events.

9.4 DETECTION OF ACCIDENTS{tc \l2 "9.4 DETECTION OF ACCIDENTS}

The TWRS-P Facility is equipped with instrumentation designed to detect the initial indicators of off normal or accident conditions. Procedures and personnel training are implemented to ensure the detection and recognition of accident indicators.

The TWRS-P Project Emergency Response Plan identifies and describes the capabilities of instrumentation used for the detection of emergency events. The types of instruments include process monitors, effluent monitors, fixed area and air radiation monitors, other fixed hazardous material monitors, and portable hazardous material (i.e., radiation and chemical) monitors.

The relationship between instrument readings, monitoring results, sample analysis, and event consequences is incorporated into implementing procedures to aid in event classification (see EALs in Section 9.3, ACategorization and Classification of Emergencies@), protective action implementation, notification, and consequence assessment.

Personnel working in the facility are trained to detect and to respond to hazards appropriately, to ensure that symptoms and indicators are recognized and given prompt response. They are trained on the use, interpretation and response to available information that may indicate the onset of an emergency event. Information can come from inspections or walkdown observations; alarms and annunciators; sampling, monitoring or measurement results, and employee or public reports.

9.5 MITIGATION OF CONSEQUENCES{tc \l2 "9.5 MITIGATION OF CONSEQUENCES}

An important part of the emergency management program for the TWRS-P Project is the planning for actions that may be needed to protect facility workers, Hanford Site workers, and the public from adverse health affects resulting from the release of hazardous materials.

9.5.1 Emergency Planning Zone{tc \l3 "9.5.1 Emergency Planning Zone}

Emergencies at the TWRS-P Facility may require actions in the vicinity of the facility, on the Hanford Site, or offsite. In accordance with the Hanford Site emergency management program (DOE/RL 94-02, Chapter 5.0), the TWRS-P Project uses the EPZ concept to focus emergency planning activities. The EPZ is an area within which the TWRS-P Project supports the Hanford, local, and state authorities in planning and preparedness activities to protect workers and the public.

The EPZ is a designated area, based upon hazards assessments, in which predetermined protective actions may be required. The methodology described in DOE/RL 94-02 is used to determine the TWRS-P Facility EPZ. The EPZ is developed in cooperation with the responsible Federal, state, and local authorities and other site facilities. The agreed upon EPZ is intended to be used by all local planning agencies as a planning tool.

9.5.2 Protective Actions{tc \l3 "9.5.2 Protective Actions}

Protective actions are measures, such as evacuation or sheltering, taken to prevent or minimize health and safety impacts on workers, responders, or the public. Typically, evacuation and sheltering are the primary protective actions considered. However, additional protective actions such as decontamination, access control, shielding, and others may also be applicable.

The TWRS-P Project Emergency Response Plan provides for the health and safety of offsite personnel through coordinated planning and action with the U.S. Department of Energy, Richland Operations Office (DOE-RL), Hanford site contractors, state, and local government authorities. The emergency plan provides for timely notification with recommendations to Hanford planning partners, state, or local authorities regarding protective actions for the site workers and the general public. Facility emergency procedures provide for immediate emergency response actions, such as the shutdown of operations or other operating actions, to be taken to prevent or reduce exposures to workers and the public. The emergency plan also describes the criteria used to determine when part or all of the facility should be shut down.

Protective action criteria are the predetermined concentrations, or exposures at which protective actions are initiated. In accordance with the requirements of DOE/RL 94-02 (Chapter 5.0) the Protective Action Guides published by the U.S. Environmental Protection Agency (EPA) and the Emergency Response Planning Guides (ERPGs) published by the American Industrial Hygiene Association (AIHA) are used for comparison with actual or potential consequences resulting from hazardous material releases to determine the appropriate emergency class and associated protective actions.

The TWRS-P Project Emergency Response Plan identifies the methodology used to develop criteria for protective action decision-making. Emergency procedures for implementing protective actions incorporate these criteria. For each specific hazardous material identified during the hazards assessment process, the numerical criterion is expressed in units that can be readily correlated with both the potential for health impact (e.g., peak concentration, cumulative dose, or exposure) and information that is available to decision makers during an emergency event (i.e., observable event indicators, results of consequence calculations, or field measurements).

Evacuation and sheltering are the most likely effective early protective actions taken to minimize risk to workers close to the event scene. Workers closest to the scene of an emergency are usually subjected to the highest risk from the effects of the accident conditions and often have the least warning time. The TWRS-P Facility emergency plan and procedures include criteria for evacuation or sheltering of workers. These criteria are related to event categorization or the declaration of certain emergency classes based on specific EALs. For different types of events the effectiveness of sheltering in place rather than evacuation is considered when establishing these criteria.

The TWRS-P Project emergency procedures provide for the timely implementation of protective actions for personnel commensurate with the potential hazards presented by the facility. The emergency plan and implementing procedures include provisions for the following:

1) Emergency signals and communications to notify personnel of protective actions
2) Personnel with permanent or temporary disabilities
3) Staging areas
4) Personnel accountability
5) Transportation methods for evacuation of personnel
6) Predetermined facility egress and evacuation routes
7) Interviews of evacuated workers to obtain information about the emergency
8) Radiological and hazardous materials monitoring and decontamination of personnel and equipment, including those evacuated from the site, as appropriate
9) Determination of the area surrounding the facility actually affected by the Operational Emergency.

The emergency plan and procedures identify assembly areas, modes of transportation, evacuation routes, and reception centers. The plan describes how evacuation instructions are provided to onsite personnel, how they move from personnel accountability areas to assembly (staging) areas for evacuation, and how transportation is provided.

In compliance with regulations, such as 29 CFR 1910.38, procedures require accounting for all employees after emergency evacuation has been completed *(procedures to be developed during Part B)*. A goal, consistent with the nature of the hazards present, is established for the amount of time required to perform the accountability check.

Plans and implementing procedures for other protective actions are established as necessary, based on the results of the facility hazards assessment. The types of actions addressed include, access control, radioprotective prophylaxis, relocation, control of foodstuffs and water, and medical care.

In emergency events, the general practice of keeping radiation and hazardous material exposures to emergency personnel as low as reasonably achievable (ALARA) is followed. Emergency personnel are equipped with dosimetry devices that allow for the evaluation of their exposures.

Procedures provide instructions to emergency personnel who are to enter areas where the hazardous material conditions are unknown. Procedures also address appropriate authorization for entry, exposure control, protective training, and instrumentation. Permanent records of internal and external radiological exposure are maintained as described in Section 3.8, ARecords Management.@

9.6 ASSESSMENT OF CONSEQUENCES{tc \l2 "9.6 ASSESSMENT OF CONSEQUENCES}

The assessment of release consequences is the evaluation and interpretation of available information concerning an actual or potential release of hazardous materials to the environment for the purpose of estimating personnel exposure. These estimates are then compared to human health and protective action criteria and used as the basis for emergency management decision-making (e.g., event classification, protective actions, notification, and public information). The primary objective of the consequence assessment process is to provide timely, useful information to emergency managers for use in making informed decisions to protect people (e.g., workers, the public, and responders). The extent of the consequence assessment capability necessary for the TWRS-P Project is determined by the results of the facility-specific hazards assessment.

Consequence assessments are conducted at several phases during emergency response. Immediately upon recognition of an emergency, tabulated results of consequence calculations are used to make an initial rough estimate of the consequences. A timely initial assessment performed in the first few minutes of response involves the use of any available real-time event and meteorological information and simplified models to estimate event-specific consequences. Continuous assessment begins with activation of the consequence assessment capability of the ERO and continues throughout the response.

In keeping with the provisions of DOE/RL 94-02, the TWRS-P Facility personnel assess the actual or potential onsite and offsite consequences of an emergency by providing the following:

1) Rapid initial evaluation of the actual or potential consequences of an emergency, including the integration of consequence assessment process with the process for categorization of an event as an emergency

2) Monitoring and evaluation of the specific indicators necessary to continually assess the consequences of the emergency

3) Integration of the consequence assessment process with the process for determining the appropriate emergency class and protective actions

4) Monitoring and evaluation of indicators related to safety, health, environmental, and security conditions that may affect the emergency

5) Projection of potential consequences, both onsite and offsite,

6) Coordination with Hanford Site, Federal, state, and local organizations to

- Locate and track hazardous materials released to the environment
- Estimate the integrated impact of such releases on workers, the public, and the environment
- Locate and recover materials removed by malevolent act, as necessary.

The emergency plan describes the activities listed above. Consequence assessment requires specific personnel, training, procedures, and equipment for estimating the released source term, obtaining meteorological data and calculating atmospheric transport and dispersion, obtaining field monitoring data, laboratory analysis, and communicating the results.

9.7 RESPONSIBILITIES OF LICENSEE AND OTHER ORGANIZATIONAL PERSONNEL{tc \l2 "9.7 RESPONSIBILITIES OF LICENSEE AND OTHER ORGANIZATIONAL PERSONNEL}

The mission of the TWRS-P Project ERO is to ensure that, during an emergency, actions are taken to prevent or minimize impacts to workers, the public, site facilities, and the environment. The ERO structure and staffing levels of trained personnel, enable a timely and effective response and meet applicable Federal, state, and local requirements. The TWRS-P Project ERO has overall responsibility for the initial and ongoing response to and mitigation of an emergency event and for coordinating with other Hanford Site, Federal, state, and local response organizations. *(Specific authorities and responsibilities for emergency response and mitigation will be developed during Part B.)*

The ERO members are assigned by name, title, or position, to carry out the required function. The ERO integrates other offsite organizations into the response, where the services and capabilities of those organizations are needed to ensure an appropriate state of readiness.

9.7.1 Emergency Response Organization Configuration{tc \l3 "9.7.1 Emergency Response Organization Configuration}

The TWRS-P Project ERO configuration is based on the results of the facility hazards assessment and the existing relationships among the TWRS-P Facility, the Hanford Site planning partners, and offsite emergency response organizations. The ERO is activated at the time an Operational Emergency is declared. The defined authorities, responsibilities, and lines of communication of the ERO supersede those of the normal operating organization for the duration of the emergency.

Each position within the ERO has clearly defined authorities, responsibilities, and tasks. One position in the ERO (e.g., the Emergency Director or similar title) has absolute, unilateral authority and responsibility to implement the emergency plan and exercise overall emergency management responsibility. The position may be transferred to more senior personnel as the ERO is fully activated. A person trained and qualified to fill this position is available at all times.

The ERO incorporates the capabilities of the normal operating organization, augmenting them as needed to meet the functional requirements specified in the TWRS-P Project Emergency Plan. Some ERO functions are performed by organizations and personnel who are not part of the normal facility operations. It may be more effective to rely on Hanford Site or offsite providers of specialized services, such as medical support or bomb disposal, than to develop those capabilities onsite. Such capabilities are clearly defined as formal mutual aid agreements or memoranda of agreement.

Procedures describe the interface between other agency response personnel and the TWRS-P Facility ERO and define points of contact. Interfaces include coordination, liaison exchange, or integration and as a result, reflect the structure of the ERO and the TWRS-P Project Emergency Response Plan.

9.7.2 Emergency Response Organization Staffing.{tc \l3 "9.7.2 Emergency Response Organization Staffing.}

Primary and backup personnel are assigned (by name, title, or position in the operating organization) to each position in the ERO, including the lines of succession for key emergency response positions. The selection process ensures that people assigned to the ERO have the necessary knowledge, skills, and qualifications to perform their duties. Personnel assigned to the ERO are trained to perform assigned emergency response functions.

Key ERO positions have formal job descriptions stating minimum qualifications and experience. At a minimum, criteria address specifications for education, related experience, familiarity with procedures, and satisfactory performance in position during a drill or exercise. The adequacy of the ERO, including its staffing, augmentation procedures, and functional capabilities, is evaluated during emergency drills and exercises.

9.7.3 Initial Response by On-Shift Personnel{tc \l3 "9.7.3 Initial Response by On-Shift Personnel}

A normal operating (on-shift) staff position has full authority and responsibility to initially perform, or oversee, the following minimum functions: detect, categorize, and classify emergency conditions;

carry out initial notifications; implement protective actions onsite; issue predetermined offsite protective action recommendations; and initiate response by appropriate onsite emergency resources (such as fire, medical, security, and hazardous materials personnel).

Upon declaration of an emergency, on-shift or on-call personnel initially fill key ERO positions and perform urgent emergency functions until designated response personnel arrive and assume their assigned ERO positions. Other ERO functions are performed by shift personnel until full staffing has been achieved.

9.7.4 Augmentation of the Emergency Response Organization{tc \l3 "9.7.4 Augmentation of the Emergency Response Organization}

The TWRS-P Project Emergency Response Plan and implementing procedures provide for ERO staff augmentation. Procedures include specific methods and information (e.g., rosters of qualified ERO personnel, telephone numbers, and paging procedures) necessary for the timely recall of the augmentation personnel. The following items are addressed in the ERO activation procedures:

1) Rapid recall of alternates if primary responders cannot be contacted

2) Different recall procedures for normal working hours, off-hours, and holidays

3) Effects of weather, concurrent emergencies on the Hanford Site, and local communication equipment limitations

4) Periodic review of rosters to verify individual qualifications for specified positions; current qualification dates; required numbers of primary and alternate personnel for all positions; current work, pager, and home phone numbers; home addresses, travel time from home to assigned response facility; and other contact information

5) Response time objectives for primary and alternate responders and the minimum staffing levels necessary to achieve different levels of emergency response capability

6) A round-the-clock staffing of the ERO for long-duration emergencies (e.g., days to weeks)

7) Site and facility access by responders during augmentation of the ERO and the potential for interference because of restricted access controls, or between nonessential personnel being evacuated and the augmentation staff being recalled

8) Assumption and transfer of emergency management and coordination functions during the time when augmentation staff are assuming their ERO duties.

9.8 NOTIFICATION AND COORDINATION{tc \l2 "9.8 NOTIFICATION AND COORDINATION}

Prompt and accurate emergency notifications are essential to mitigate consequences and to protect the health and safety of workers and the public. Emergency notification procedures provide timely notice to the emergency response organizations, Hanford Site and facility workers, and offsite agencies under the most limiting set of conditions.

Notifications and reporting are performed in accordance with DOE/RL 94-02 and applicable Federal, state, or local requirements, such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Resource Conservation and Recovery Act (RCRA); and the Emergency Planning and Community Right-to-Know Act.

The TWRS-P Project Emergency Response Plan discusses the required and proceduralized notification process for onsite and offsite notifications for all operational emergencies, including:

1) Personnel (positions) responsible for both initiating and receiving notifications

2) The methods used to perform notification

3) The notification procedure for termination of an incident

4) Personnel (positions) required to be notified for any emergency

5) The circumstances under which the DOE and Hanford Contractors are notified of an emergency

6) Descriptions of the communications interfaces with offsite organizations

7) The equipment to be used for notification, backup equipment, and testing procedures.

All aspects of notification are preplanned, documented, tested under a variety of conditions, and implemented through approved notification procedures, reliable primary and backup communications equipment, and formal training programs.

9.9 DESCRIPTION OF THE EMERGENCY OPERATIONS CENTER{tc \l2 "9.9 DESCRIPTION OF THE EMERGENCY OPERATIONS CENTER}

The EOC is the primary emergency facility from which the emergency management component of the ERO carries out the emergency response functions and responsibilities. (see also 9.1.1.2, AEmergency Operation Center.@) The design and operations provide for effective emergency response based on an analysis of emergency response needs, with consideration given to human interface requirements. The EOC is designed to remain operational and life-supporting for an extended period of time under accident conditions (as derived from the facility hazards assessment) and maintain its structural integrity under various events, including natural phenomena. The design also follows human-factor principles for comfort, noise reduction, lighting, and work-group interfaces. Work space and equipment are provided to permit response personnel to perform their functions, especially command and control. *(If the EOC is to be a dual-use facility where non-emergency operations take place, then plans and procedures will be developed and tested to ensure the facility can be rapidly converted into an EOC during an emergency.)*

(If the results of the facility hazards assessment indicate that it is possible for the primary EOC to become uninhabitable during an emergency, then provisions will be made for an alternate EOC. The alternate may not duplicate all design features and equipment of the primary EOC, but will allow response personnel to perform necessary functions in an effective manner. The alternate

EOC will be located so that the likelihood of both the primary and the alternate EOC being rendered uninhabitable by the same event is minimized. Transfer and activation procedures will be prepared for shifting responsibilities from the primary to the alternate EOC during an emergency.)

The hazards assessment results identify potential locations and habitability requirements for all emergency facilities. Consequence estimates derived from the hazards assessment identify areas potentially affected by hazardous materials releases. The need for a determination of habitability or an alternate EOC is eliminated if an EOC is located outside any potentially affected area. Habitability requirements for an EOC located within a potentially affected area are determined by the consequence estimates.

The TWRS-P Facility emergency plan discusses primary and backup facilities to be used for emergency response and the equipment likely to be used for responding to emergencies. The equipment capability, equipment limitations, quantity of equipment, locations of both fixed and portable equipment, consumables, maintenance requirements, certification requirements, expiration dates, and equipment compatibilities are also be addressed in the plan.

9.10 INFORMATION COMMUNICATED AND THE PARTIES CONTACTED{tc \l2 "9.10 INFORMATION COMMUNICATED AND THE PARTIES CONTACTED}

A timely, reliable, and accurate communications system is essential for notifications, since it supplies the framework for conducting response operations. Establishing adequate communications to support on-scene activities is a time-urgent operation. Equally important to effective management of the emergency response is timely establishment of communications to offsite support organizations. Elements of the TWRS-P Project communications system include the communications equipment, a notification system, and an information management structure. Emergency communications equipment for the TWRS-P Project is discussed in Section 9.1.2.1, ACommunications Equipment.@ The notification system is discussed in Section 9.8, ANotification and Coordination.@ Actions to mitigate the consequences of a release of hazardous material by providing protective action recommendations to offsite authorities are discussed in Section 9.5, AMitigation of Consequences.@

The severity of the accident consequences, as indicated by the results of the facility hazards assessment, determines which Hanford and offsite officials are notified. Also, applicable Federal, state, and local requirements determine other agencies that must be notified in the event of a release of hazardous materials. Notifications and information transmittal concerning emergencies at the TWRS-P Facility are consistent with the requirements of DOE/RL 94-02 and agreements established within the Hanford Emergency Planning community. *(The specific agencies to be notified and the responsibility for notification will be developed during Part B.)*

For example, Hanford Site organizations that may need to be notified by TWRS-P Facility management following the declaration of an Operational Emergency include;

1) Hanford Patrol Operations Center
2) DOE-RL EOC
3) Pacific Northwest National Laboratory
4) Fluor Daniel Hanford
5) Hanford Environmental Health Foundation

6) Hanford On-call Emergency Duty Officer
7) Hanford Fire Department.

Notifications made by the Patrol Operations Center following the declaration of an Operational Emergency at the Hanford Site include:
1) U.S. Department of Energy Headquarters (DOE-HQ) EOC
2) Washington Public Power Supply System (WNP-2)
3) Benton and Franklin County EOC dispatch center
4) Grant County EOC
5) Washington State EOC
6) Oregon EOC.

The Hanford Occurrence Notification Center Duty Officer and available staff make the following offsite notifications after event classification, as applicable:

1) Federal Aviation Administration
2) U.S. Coast Guard
3) Siemens Nuclear Power Corporation
4) Federal Emergency Management Agency (Region 10)
5) EPA (Region 10)
6) Washington State Department of Ecology
7) Washington State Department of Health
8) Bonneville Power Administration
9) U.S. Ecology Company
10) U.S. Fish and Wildlife Services.

9.11 PUBLIC NOTIFICATION{tc \l2 "9.11 PUBLIC NOTIFICATION}

The ability of the TWRS-P Project to provide the public, media and employees with accurate and timely information depends on an effective emergency public information program. Information released to the public on any emergency situation at the TWRS-P Facility is coordinated with onsite and offsite Federal, state, and local emergency response organizations. The program provides the means for the TWRS-P Facility ERO to coordinate the timely exchange of information among representatives from the Hanford Site and other organizations. This coordination is critical to prevent dissemination of confusing, conflicting, and erroneous information.

9.11.1 Joint Information Center{tc \l3 "9.11.1 Joint Information Center}

As directed by DOE/RL 94-02, public information activities at the Hanford Site are coordinated with offsite agencies through a JIC. (See Section 9.1.1.3, AEmergency Public Information.@) *(BNFL Inc. plans to negotiate an agreement to allow the TWRS-P Project to use the Hanford JIC during an emergency response.*)

In the emergency public information program, the JIC is the single point from which information is released. This allows the TWRS-P Project, DOE-RL, Hanford Site Contractors, and offsite agencies to coordinate the accurate and timely release of public information. During an Operational Emergency at the TWRS-P Facility, affected Hanford and offsite agencies are encouraged to participate in the JIC. The JIC is the sole source of information to the public on the event, corrective actions and potential ramifications. Additionally, local authorities can use the JIC as their means to provide information to the media and the public.

The information release functions of the JIC include:

1) Coordination of news releases with affected agencies
2) Conducting news conferences with participation from DOE-RL, Site Contractors, and offsite agencies

3) Rumor control

4) Response to telephone inquiries from the public and media

5) Information to employees.

The emergency response plan describes the program to provide information and answer questions from the media and the general public concerning the emergency, including information release approval and rumor control. The facilities and communications equipment used to disseminate information to the public are identified.

9.11.2 Public Education{tc \l3 "9.11.2 Public Education}

As described in Section 9.2, APublic Education,@ of DOE/RL 94-02, the Hanford Site is committed to assist the jurisdictions within Hanford Site EPZs with the development and implementation of programs to educate their residents on the actions to take in the event of an emergency at the Hanford Site. The TWRS-P Project supports and participates in programs to educate the public concerning emergency response.

The TWRS-P Project Emergency Response Plan describes the education program to inform the public and the workers of the hazards present at the TWRS-P Facility, and provide information that can be used for emergency actions, including recommended evacuation routes and sheltering.

9.12 TRAINING{tc \l2 "9.12 TRAINING}

The TWRS-P Project Emergency Management training program is designed to ensure that personnel are prepared to respond to, manage, mitigate, and recover from emergencies associated with facility operations (see Section 3.4, ATraining and Qualification@). The emergency preparedness training program includes a mix of classroom instruction, tabletop exercises or walk-throughs, and drills. Training is provided for personnel assigned to the facility ERO, onsite response personnel (i.e., fire, medical, security, health physics, industrial hygiene, and hazardous material response personnel), general employees, and members of Hanford and offsite response organizations. The scope of the program includes initial training and annual retraining for both onsite incidents, including transportation incidents, and offsite incidents that could affect the TWRS-P Facility.

The proficiency developed through the training program is tested by a separate exercise component of the emergency management program (see Section 9.14, ADrills and Exercises@). The scope of the training program is consistent with the hazards identified in the facility hazards assessment. The individual training modules focus on the functional position and responsibilities of the trainee.

Annual retraining for emergency response-assigned personnel includes lessons learned from past drills and exercises, changes to plans and procedures, and lessons learned from emergencies at DOE facilities and other industrial facilities. Personnel assigned to the TWRS-P Facility ERO receive training prior to assignment to an activation list and at least annually thereafter.

Training is also provided annually to facility workers who may have to take protective actions in the event of an emergency. This is provided through general employee training and participation in drills and exercises.

The emergency preparedness training program for the TWRS-P Project requires that training records are maintained. The system includes a means for tracking attendance, and a system for reminding employees when training is needed.

The emergency response plan describes the goals and objectives of the training and drills program, courses given to emergency management personnel, and the training requirements for key emergency management positions and response teams. The lessons learned, goals, frequency, and complexity of courses, drills, and employee requirements for training and retraining, or refresher training, are identified. The plan also describes the system of training required for visitors, vendors, and subcontractors; the training to be made available to offsite organizations in order to support their abilities to participate in site emergency response actions; and the system of record keeping to verify training requirements are met.

9.13 PROCEDURES FOR SAFE SHUTDOWN AND RECOVERY{tc \l2 "9.13 PROCEDURES FOR SAFE SHUTDOWN AND RECOVERY}

The facility emergency operating procedures are based on the analyses performed in the FSAR. These procedures contain specific instructions for facility operations personnel on the safe shutdown of facility processes for all identified and emergency conditions. Some of this information is addressed in Section 4.8, AControls for Prevention and Mitigation of Accidents.@

Recovery consists of those actions taken to return the facility to normal operation after a facility has been brought to a stable or shutdown condition. In general, the recovery period begins when the emergency response to an Operational Emergency is declared terminated. The recovery period continues until the facility and any affected areas meet predetermined criteria for the resumption of normal operation or use. Recovery activities can include, but are not limited to; damage assessment, environmental consequence assessment, long-term protective action determinations, facility and environmental restoration, and dissemination of information.

The results of the facility-specific hazards surveys and assessments are used to help establish the basic criteria and organizational structure necessary for conducting recovery activities. The TWRS-P Project Emergency Response Plan requires specific procedures, criteria and other aids to identify the point at which emergency response activities can be terminated and to coordinate the start of a program for achieving operational recovery. Planning and implementation of termination and recovery activities is coordinated with the needs and requirements of the Hanford Site, state, and local EROs.

Prior to terminating an emergency response, the TWRS-P Facility ERO recovery organization determines the major recovery actions and resources needed to begin recovery operations. The recovery organization is responsible for coordinating all recovery activities. Responsibilities include, but are not limited to, prioritization of activities; protection of worker and general public health and safety; dissemination of information; coordination of TWRS-P Facility site, Hanford Site and offsite activities; collection of data and assessment of long-term effects associated with the release of hazardous materials; formulation and implementation of long-term protective actions for the affected areas; and, providing assistance, as requested, to the Hanford Site, and state and local agencies in formulating long-term protective actions for affected areas.

In summary, the TWRS-P Project Emergency Response Plan discusses:

1) Criteria for reentering areas under emergency conditions or areas that had access restricted during the emergency

2) Provisions to place and maintain the facility in a safe state following an accident

3) general criteria to be met for the termination of emergency response

4) Procedure for identification of a recovery organization and the development of a recovery plan

5) Personnel who can develop, approve, or implement reentry, and their relationship to the emergency organization

6) System to ensure safe shutdown of operations following the declaration of an emergency.

9.14 DRILLS AND EXERCISES{tc \l2 "9.14 DRILLS AND EXERCISES}

Drills and exercises train workers and validate the efficiency of the emergency management program. Each member and alternate of the TWRS-P Facility ERO participates in a drill or exercise at least annually to demonstrate their proficiency in response duties. Emergency management improvements and corrective actions identified during actual emergencies or during drills and exercises are incorporated into the emergency management program.

Drills train personnel in their related responsibilities and procedures (i.e., in the use of emergency equipment; in team interactions; and in coordinating their organization with other EROs). The scope and the frequency of drills ensure adequate response capability in all applicable areas. Additionally, drills emphasize facility-specific emergency events and response activities and minimize the use of generic, nonspecific simulations.

Emergency management exercises are evaluated demonstrations of the integrated capabilities of emergency response resources (personnel, procedures, facilities, and equipment) conducted for the purpose of validating elements of the emergency management program. Exercises are intended to be realistic simulations of emergencies and include command, control, and communication functions and event-scene activities. These exercises may vary significantly in size and scope to achieve their respective purposes.

Exercise-specific objectives establish the exercise scope, specify the emergency response functions to be demonstrated, identify the extent of organizational and personnel participation, and identify exercise activities to be accomplished or simulated. Typically, not all emergency management program elements are demonstrated in each exercise and a systematic approach is used, with emphasis on participation and coordination among the emergency response organizations, to demonstrate aggregate response capabilities over a period of time.

An exercise control organization ensures each exercise is conducted in a safe and effective manner in accordance with the exercise plan. An evaluation team determines if objectives are met and identifies issues to be corrected. Issues identified during drills and exercises are tracked until a resolution is completed.

Response organizations, including Hanford Site, state, local, and other appropriate federal organizations, are asked to participate in exercises. Participation by these organizations is dependent on the scenario and the desire of each organization to participate. When an organization responds affirmatively to the invitation to participate in exercises, they are included.

9.15 PROCEDURES FOR IDENTIFYING, LOCATING AND CONTROLLING HAZARDOUS CHEMICALS{tc \l2 "9.15 PROCEDURES FOR IDENTIFYING, LOCATING AND CONTROLLING HAZARDOUS CHEMICALS}

Procedures for identifying, locating, and controlling hazardous chemicals used or stored onsite are in place prior to their introduction into the TWRS-P Facility and are discussed in Chapter 7.0, AChemical Safety.@

The chemicals addressed by the emergency management program are identified during the preparation of the facility-specific hazards survey and hazards assessment as discussed in Section 9.2, ATypes of Accidents.@

9.16 RESPONSIBILITIES FOR DEVELOPING AND MAINTAINING THE EMERGENCY PROGRAM AND PROCEDURES{tc \l2 "9.16 RESPONSIBILITIES FOR DEVELOPING AND MAINTAINING THE EMERGENCY PROGRAM AND PROCEDURES}

The TWRS-P Project Environment, Safety, and Health Manager is responsible for the development and maintenance of the emergency management program. The major program administration tasks involve the development (or coordination of development) and maintenance of technical support documents, plans, and procedures; the coordination of activities; and maintenance of appropriate auditable records. The program administrator ensures that the Emergency Response Program coordinates and integrates the emergency planning and preparedness requirements of applicable Federal, state, and local laws, regulations, and ordinances.

An annual appraisal of the emergency management program is conducted to assess the adequacy of emergency preparedness and compliance with all applicable requirements. These assessments are conducted by personnel not directly responsible for performing the functions being assessed. (See also Section 3.6, AAudits and Assessments.@)

The TWRS-P Project Emergency Response Plan and implementing procedures are controlled documents. The document control system ensures that controlled copies are up to date, and are available at locations where they are needed during an emergency.

The TWRS-P Project Emergency Response Plan and emergency implementing procedures are reviewed annually and revised as necessary. Agreements with local, state, and Federal officials and agencies are reviewed and updated as necessary, at least annually. Copies of documents and records that support the emergency management program (i.e., technical data, hazards survey and assessment, and plans and procedures) are maintained. Records of training, drills, and exercises are maintained to document status of the program and provide direction for improvements. (See Section 3.8, ARecords Management.@)
The emergency implementing procedures require maintaining records produced during emergency response that contain information for review and reconstruction of major communications and actions taken during an emergency. These records include logs and documentation produced by the emergency response organization. (See Section 3.8, ARecords Management.@)

In summary, the TWRS-P Project Emergency Response Plan identifies the responsibilities of the Emergency Management Program Administrator; the procedure used to control the Emergency Response Plan and to assure periodic review and update; the site internal assessment program; and the provisions for document control and records management.

10.0 ENVIRONMENTAL PROTECTION{tc \l1 "10.0 ENVIRONMENTAL PROTECTION}

Environmental protection for Tank Waste Remediation System-Privatization (TWRS-P) construction, operation, and decommissioning is addressed in the TWRS-P Facility environmental report (BNFL 1997c).

11.0 DEACTIVATION AND DECOMMISSIONING{tc \l1 "11.0 DEACTIVATION AND DECOMMISSIONING}

By Table 4-1 of the BNFL Inc. (DOE-RL 1996d), with U.S. Department of Energy (DOE) contract BNFL Inc. is required to submit in a deactivation plan during Part A. This plan will be submitted as *TWRS-Privatization Project: Deactivation Plan* (BNFL 1998b). The TWRS-P Facility technical report (BNFL 1998c), also to be submitted in Part A, will provide information on design provision to accommodate deactivation and decommissioning. Financial considerations for deactivation will be provided in the *Business and Finance Plan* (BNFL 1998a). In addition, the TWRS-P Facility incorporates provisions in the original design to facilitate deactivation and the final decommissioning. These provisions reduce radiation exposure to Hanford Site personnel and the public during and following deactivation and decommissioning activities and reduce the amount of radioactive waste generated during deactivation.

The deactivation plan will describe the deactivation strategy to achieve a safe, stable, and passive facility for turnover to DOE with minimal requirements for service support from either personnel or active equipment. The deactivation plan will provide details on how the following activities will be accomplished to achieve a deactivated status for the facility:

1) Verifying the completion of the facility deactivation end point (The term Afacility deactivation end point@ refers to the set of conditions that comprise the completion of facility deactivation i.e. radiological, structural, equipment, and documentation.)

2) Documenting the regulatory status, conditions, and inventories of remaining radioactive and hazardous materials and health and safety requirements

3) Modifying the facilities, structures, support systems, and surveillance systems to provided for confinement and monitoring of the remaining contamination, radiation, and any other potential hazards

4) Posting and securing of the facility

5) Removing packaged special nuclear materials and other packaged radiological and chemical materials

6) Confirming that security systems and procedures are adequate and in place to prevent unauthorized entry.

12.0 DEFINITIONS{tc \l1 "12.0 DEFINITIONS}

In the following list, the parenthetical information following the term being defined is the source of the definition. However, the wording provided may be tailored to the TWRS-P Project use and, therefore, may not be exactly as contained in the referenced source.

Accident Risk Goal (DOE/RL-96-0006 [DOE-RL 1996b]). The risk, to an average individual in the vicinity of the contractor=s facility, of prompt fatalities that might result from an accident should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population generally are exposed. For evaluation purposes, individuals are assumed to be located within 1 mile of the contractor=s controlled area.

Acute Hazard (AIChE 1992). The potential for injury or damage to occur as a result of an instantaneous or short duration exposure to the effects of an accident.

Administrative Control. A condition or activity carried out by facility personnel and governed by procedure or training that serves to contribute to the safe operation of the facility.

As Low as Reasonably Achievable (10 CFR 835). The approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. The ALARA approach is not a dose limit but a process that has the objective of attaining doses as far below the applicable limits of this part (10 CFR 835) as is reasonably achievable.

Codes and Standards. Document containing expressed expectations for the performance of work; normally refers to those practices issued by consensus organizations (e.g., American National Standards Institute, American Society of Mechanical Engineers, and National Fire Protection Association).

Co-located Worker (DOE/RL-96-0004). An individual within the Hanford Site, beyond the Contractor-controlled area, performing work for or in conjunction with DOE or utilizing other Hanford Site facilities.

Common Cause Failure (AIChE 1992). The occurrence of two or more failures that result from a single event or circumstance.

Consequence (AIChE 1992). The direct, undesirable result of an accident sequence usually involving a fire, explosion, or release of toxic material. Consequence descriptions may be qualitative or quantitative estimates of the effects of an accident in terms of factors such as radiological exposure, health impacts, economic loss, and environmental damage.

Consequence Analysis (AIChE 1992). The analysis of the effects of incident outcome cases independent of frequency or probability.

Contractor Controlled Area. The physical area enclosing the TWRS-P Facility by a common perimeter. Access to this area is controlled by BNFL. The contractor controlled area may include identified restricted areas.

Deactivation (Contract, Attachment 9 [DOE-RL 1996c]). The process of permanently ceasing active operation at a facility in a planned and controlled manner to support follow-up decontamination and decommissioning activities. A process whereby non-essential systems and/or equipment in a shutdown facility are deenergized, drained and flushed, isolated, or removed to minimize the long-term costs of maintaining the facility in a physically safe and environmentally secure condition. Includes the removal of fuel and stored radioactive and/or hazardous waste from the facility and implementation of appropriate facility safety requirements.

Design Basis Earthquake. The seismic event whose response spectra are defined by those provided in SRD Volume II, Safety Criterion 4.1-3 (Table 4-1 and Figure 4-1).

Design Class I. Structures, systems, or components that by performing their specified safety function, prevent the maximally exposed member of the public from receiving a radiological exposure that exceeds the exposure standards defined in the SRD. Design Class I also applies to those features that by functioning, prevent the maximally exposed member of the public from receiving a chemical exposure that exceeds the ERPG-2 (AIHA 1988) chemical release standard and those features credited for the prevention of a criticality event.

Design Class II. Structures, systems, or components that by performing their specified safety function, prevent workers from receiving a radiological exposure that exceeds the worker exposure standards defined in the SRD. Design Class II also applies to those features that by functioning, prevent workers from receiving a chemical exposure that exceeds the ERPG-2 (AIHA 1988) chemical release standard.

Deterministic Analysis. A nonprobabilistic approach to accident analysis that begins with the establishment of a specific set of credible accident initiating events expected to represent a range of possible challenges to the safety of the facility and some of which are expected to define the design requirements for the facility. The design of the facility is then evaluated to this set of events using conservative inputs and assumptions to account for uncertainties, to ensure that adequate controls exist to protect the workers and public such that radiological and chemical exposure standards are satisfied. In the evaluation of public safety, the most limiting random single active failure of a system or component is assumed and credit is taken only for those structures, systems, and components that meet Design Class I requirements. Other than selecting credible events to account for accident likelihood, this is a consequence-oriented rule-followed approach (i.e., assume worst single failure) to establish the design of the facility. In the evaluation of worker safety, only those SSCs that meet Design Class I and II requirements are credited.

Double-shell Tank (Contract, Attachment 9 [DOE-RL 1996c]). A reinforced concrete underground vessel with two steel liners to provide containment and backup containment of liquid wastes. The annulus is instrumented to permit detection of leaks from the inner liner. At the Hanford Site, there are 28 double-shell tanks. Tank 241-AP-106 is a double-shell tank.

Emergency Response Planning Guidelines (AIChE 1992). A system of guidelines for airborne concentrations of toxic materials prepared by the American Industrial Hygiene Association (AIHA).

Engineered Feature. A structure, system, or component that contributes to the safe operation of the facility.

Episodic Event (AIChE 1992). An unplanned event of limited duration, usually associated with an accident.

ERPG-2 (AIHA 1988). The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

External Event. An event external to the TWRS-P Facility caused by (1) a natural hazard (e.g., earthquake, flood, lightning, or range fire) or (2) a human-induced event (e.g., transportation or nearby industrial activity).

Final Safety Evaluation Report. A report issued by the Director of the Regulatory Unit that documents the RU review of the facility.

Hanford Site. A 1,450 km^2 reservation in southeast Washington State owned by the Federal Government. Established in 1943 as part of the Manhattan Project, the initial activity on the Hanford Site was to produce plutonium for use in nuclear weapons for the nation's defense. The Hanford Site has had nine production reactors and four chemical separation plants. The current mission on the Hanford Site is environmental cleanup and development of related technologies.

Hazard (AIChE 1992). An inherent physical or chemical characteristic that has the potential for causing harm to people, property, or the environment. A hazardous situation is the combination of a hazardous material, an operating environment, and certain unplanned events that could result in an accident.

Hazard and Operability Analysis (AIChE 1992). A systemic method in which process hazards and potential operating problems are identified using a series of guide words to investigate process deviations.

Hazardous Material. A solid, liquid, or gaseous material that is toxic, explosive, flammable, corrosive, or otherwise physically or biologically threatening to health.

Highly Hazardous Chemical. Relative to implementation of 29 CFR 1910(m), a highly hazardous chemical is a substance possessing toxic, reactive, flammable, or explosive properties and is specified in Appendix A of 29 CFR 1910.119.

High-Level Waste (Contract, Attachment 9 [DOE-RL 1996c]). The highly radioactive waste material that results from the operation of the first-cycle solvent extraction system or equivalent, and subsequent extraction cycles or equivalent that contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

High Radiation Area (10 CFR 835). Any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Human Factors (AIChE 1992). A discipline concerned with designing machines, operations, and work environments to match human capabilities, limitations, and needs. Among human factors specialists, this general term includes any technical work (engineering, procedure writing, worker training, worker selection) related to the person in operator-machine systems.

Independent Safety Review Team. A group of individuals with the demonstrated knowledge and expertise to confirm the completeness, credibility, and adequacy of the TWRS-P Project radiological, nuclear, process safety documents, and recommend their approval to the TWRS-P Project Manager.

Initial Safety Evaluation Report (DOE/RL-96-0004). A report issued by the Director of the Regulatory Unit, that documents the capability or potential for obtaining future authorizations for construction, operation, and deactivation.

Initiating Event (AIChE 1992). The first event in an event sequence. Can result in an accident unless engineered protection systems or human actions intervene to prevent or mitigate the accident.

Internal Event. An occurrence related to structure, system, and component performance or human action, or an occurrence external to the system but within the TWRS-P Facility that causes upset of a structure, system, or component.

Licensee Controlled Requirements. Those requirements that define the conditions necessary to ensure the worker radiological and chemical exposure standards of the SRD are not exceeded for credible events. Licensee Controlled Requirements (LCR) are established to ensure that a process variable, design feature, or operating restriction that is an initial condition (i.e., the assumed facility state) for an accident analysis is maintained. LCRs are also established to ensure that structures, systems, and components credited for meeting the worker exposure standards will function when called on to prevent or mitigate credible events. Changes to the LCRs can be made by BNFL Inc. provided no unreviewed safety question is identified.

Licensing Basis. The composite of information provided by BNFL Inc. in response to radiological, nuclear, and process safety requirements that is the basis on which the Director of the Regulatory Unit grants approval to operate the TWRS-P Facility. The licensing basis is functionally equivalent to the DOE authorization basis.

Likelihood (AIChE 1992). A measure of the expected probability or frequency of an event's occurrence.

Limiting Conditions for Operations (DOE/RL-96-0004). The lowest functional capability or performance level of equipment required for safe operation of the facility.

Low-Activity Waste (Contract, Attachment 9 [DOE-RL 1996c]). Waste that contains radioactivity and is not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or by-product material, as defined in Section IIc(2) of the *Atomic Energy Act of 1954*, (42 USC 2014(e)(2)).

Major Accident. Relative to implementation of the incident investigation and reporting requirements of 29 CFR 1910.119(m), a major accident is a major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemicals or radioactive materials, that presents serious danger to facility worker.

Mitigative Feature. A structure, system, component, or administrative control that serves to reduce the consequences of a hazardous situation or accident.

Normal Operation (DOE/RL-96-0004). Steady-state operation and those departures from steady-state operation expected frequently or regularly in the course of facility operation, system testing, and maintenance. It includes conditions such as startup, shutdown, standby, anticipated operational occurrences, operation with specific equipment out of service as permitted by the approved operational constraints, and routine inspection, testing, and maintenance of components and systems during any of these conditions if it is consistent with the approved operational constraints.

Operations Risk Goal (DOE/RL-96-0006 [DOE-RL 1996b]). The risk to the population (public and workers) in the area of the Contractor=s facility, of cancer fatalities that might result from facility operation should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks to which members of the U.S. population generally are exposed. For evaluation purposes, individuals are assumed to be located within 10 miles of the controlled area.

Preventative Feature. A structure, system, component, or administrative control that serves to preclude the occurrence of a hazardous situation or accident.

Probabilistic Analysis. An approach to accident analysis that addresses all credible initiating events and that is risk-based in that it considers both the likelihood and consequences of accidents to determine overall risks. Mitigating system and component reliability as well as human performance are assessed probabilistically to support risk-informed decision making. The probabilistic analysis goes beyond the single failure requirements of the deterministic approach in that it assesses the probabilities of multiple failures as well. This is a Abest-estimate@ analysis in that realistic input and modeling assumptions are used and all of the available structures, systems, and components are considered that can prevent or mitigate the event. The evaluation of the availability and reliability of structures, systems and components considers failure to start and failure to run as well as maintenance-caused unavailabilities.

Process. An activity involving a chemical including use, storage, manufacturing, handling, or the onsite movement of such chemicals, or a combination of these activities.

Process Hazards Analysis. The identification of hazards and the analysis of the significance of hazardous situations associated with a process or activity. It includes preliminary hazard analysis and Hazard and Operability Analysis (HAZOP).

Process Safety (DOE/RL-96-0004). The operation of facilities that handle, use, process, or store hazardous materials in a manner free of episodic or catastrophic incidents. However, the handling, use, processing, and storage of materials with inherent hazardous properties can never be done in the total absence of risk. Process safety is an ideal condition towards which one strives.

Process Safety Management (DOE/RL-96-0004). The application of management systems to the identification, understanding, and control of process hazards to prevent process-related injuries and incidents. The TWRS-P Project process safety management program complies with 29 CFR 1910.119, AProcess Safety Management of Highly Hazardous Chemicals.@

Public (DOE/RL-96-0004). Individuals who are not occupationally engaged at the Hanford Site. The term Apublic@ is considered synonymous with Aoffsite receptor@ when evaluation the consequences of accidents.

Public Radiological Exposure Standards. A set of radiological exposure acceptance standards that have been established for the protection of the public. The standards are a function of the frequency of occurrence of the initiating event. The standards are used for the purpose of establishing the need for Design Class I prevention and mitigation structures, systems, components, and administrative controls.

Radiation Exposure. Radiation exposure, as used in TWRS-P Project documents, is the exposure of people (public, facility workers, co-located workers) to ionizing radiation produced by radioactive material. Unless otherwise specified, radiation exposure means the total effective dose equivalent (TEDE), that is, the sum of external and internal exposures. External exposures are assessed as the resulting effective dose equivalent; internal exposures as the resulting committed effective dose equivalent. Other terms used in TWRS-P Project documents, such as radiological exposure, dose, radiation dose, and the like, are taken as synonymous to radiation exposure.

Radiological, Nuclear, and Process Safety (Contract, Attachment 9 [DOE-RL 1996c]). Those actions taken to control the hazards incident to possession, use, and disposal of radioactive and nuclear material, and the processing of hazardous chemicals.

Radiological Worker (10 CFR 835). A general employee whose job assignment involves operation of radiation-producing devices, or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year total effective dose equivalent (TEDE).

Regulatory Guides. Documents that describe methods acceptable to the U.S. Nuclear Regulatory Commission (NRC) staff for implementing specific portions of NRC regulations. Some regulatory guides lay out steps taken by the staff in evaluating specific situations. Others provide guidance to applicants concerning information needed by staff in its review of applications for permits and licenses, or refer to or endorse national standards.

Regulatory Unit. The DOE Richland Operations Office organization executing nuclear, radiological, and process safety regulatory authority for the TWRS-P Project.

Reportable Occurrence. An incident reported to the DOE incident reporting and process system and other Federal or state agencies. The threshold for reporting will be provided in the TWRS-P Facility Incident reporting procedure, to be developed in Part B.

Requirements. Items that are mandated by an authority through stature, regulations, and contract.

Restricted Area (DOE/RL-96-0004). An area identified by the Contractor to which access is limited for the purposes of protecting individuals against undue risk from exposure to radiation and radioactive materials. Only a radiation worker is allowed into this area.

Risk (AIChE 1992). The combination of the expected frequency (events/year) and consequence (effects/event) of a single accident or a group of accidents.
Risk Assessment (AIChE 1992). The systematic application of management policies, procedures, and practices to the tasks of analyzing and controlling risk in order to protect employees, the general public, the environment, and company assets.

Safe State (DOE/RL-96-0004). A situation in which the facility process has been rendered safe and no pressurized material flow occurs in the process lines. Any active, energy generating, process reactions are in controlled or passive equipment. The structures, systems, and components necessary to reach and maintain this condition are functioning in a stable manner, with all process parameters within normal safe state ranges.

Safety Analysis Report (DOE/RL-96-0004). A document that fully describes the analyzed safety basis for the facility (safety envelope), fully demonstrates that the facility will perform and will be operated such that radiological, nuclear, and process safety requirements are met, and fully demonstrates adequate protection of the public, the workers, and the environment.

Safety Criterion. A measurable and/or demonstrable statement of an expected condition that ensures adequate protection of the workers and the public. In satisfying the full set of Safety Criteria, the TWRS-P Project ensures that an acceptable status or condition protecting the public and/or workers has been achieved and/or maintained.

Safety Limits. Limits on process variables required to ensure the public radiological and chemical exposure standards of the SRD are not exceeded for credible events.

Seismic Category I. The seismic designation assigned to those Design Class I and II SSCs that must withstand the effects of the design basis earthquake without loss of capability to perform their specified safety functions such that the worker and public accident exposure standards are not exceeded as the result of the design basis earthquake. Seismic Category I SSCs are designed to perform their specified safety function for the seismic loads defined in SRD Volume II, Safety Criterion 4.1-3 (Table 4-1). Other SSCs may be categorized as Seismic Category I for other purposes such as reliability and investment protection.

Seismic Category II. The seismic designation assigned to those portions of SSCs whose continued function during or after the design basis earthquake is not required but whose failure could prevent Design Class I or II SSCs from performing their specified safety functions associated with a design basis earthquake. Seismic Category II SSCs are designed to maintain their structural integrity as necessary to protect the Design Class I and II SSCs and are designed for the seismic loads defined in SRD Volume II, Safety Criterion 4.1-3, Table 4-1. A static analysis may be applied to Seismic Category Class II SSCs. In addition, piping is designed to meet faulted conditions, ductwork is not allowed to collapse, and structures are designed and analyzed to demonstrate that the design basis earthquake will not cause failure of the protected Design Class I or II SSC to perform the specified safety function.

Seismic Category III. The seismic designation assigned to SSCs whose function or structural integrity need not be maintained during or after a design basis earthquake. Seismic Category III SSCs are designed to the seismic loads defined in SRD Volume II, Safety Criterion 4.1-3

Table 4-2.

Specified Safety Function. That attribute of a Design Class I or II engineered control credited in safety analysis for maintaining worker and/or public exposure below accident standards.

Technical Safety Requirements. Those requirements that define the conditions necessary to ensure the public radiological and chemical exposure standards of the SRD are not exceeded for credible events. Technical Safety Requirements (TSR) are established to ensure that a process variable, design feature, or operating restriction that is an initial condition (i.e., the assumed facility state) for an accident analysis is maintained. TSRs are also established to ensure that structures, systems, and components credited for meeting the public exposure standards will function when called upon to prevent or mitigate credible events. Changes to the TSRs can only be made upon approval of the regulator.

Validation. As applied to procedures, validation is the process that ensures an administrative control provides sufficient and understandable guidance and direction to the craft person and that it is compatible with the equipment or system being maintained. Validation is typically performed in the field prior to initial procedure use.

Verification. As applied to procedures, verification is the review to ensure the proper format and technical accuracy of a new or revised procedure. This review also ensures that the format incorporates human factors principles and other appropriate administrative policies.

Worker. When used unmodified, Aworker(s)@ refers to facility worker(s) and co-located worker(s).

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